METAL INDUSTRY

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# New Lines

MOST alloys nowadays are the subjects of standard rather than patent specifications. Indeed, many of the latter have expired such a long time ago that users of the alloys to which they related may never even have heard of the interest with which the compositions, which they now regard as standard, were originally greeted, and may know nothing of the twists and turns the patent specifications claiming these compositions had to survive. Many of these alloys such as Muntz Metal, Delta Metal, Babbit Metal and Duralumin have succeeded in achieving the dignity of incorporation into standard dictionaries and have thus added new words to our language. Incidentally, one of the major headaches with which the holders of the original patents are wont to be afflicted is the difficulty of ensuring that the names of the alloys shall be regarded as Trade Names and not be used indiscriminately to cover the products, similar though they may be in composition, of other manufacturers.

It must not be inferred that alloy compositions have ceased altogether to put in an appearance at the Patent Office. Their numbers have, however, greatly diminished of recent years and their nature has changed. Like so many other things, alloys have followed the trend towards specialization. Where, formerly, the compositions claimed, which, in many cases, were notable for the extreme width of their ranges, were described as possessing a large number of excellent properties making them suitable for numerous general purposes, those of their successors are much more specialized. There is, for example, the alloy intended for use as a friction facing on the steel clamping devices used in steel pit props of the yielding type. This alloy will not spark when rubbed against steel, and ensures a steady uniform frictional resistance without intermittent sticking and slipping. It is based on zinc of 99·99 per cent purity, and preferably contains 25 per cent manganese, 15 per cent copper, and 0·07-0·15 per cent aluminium.

In a different field there is the alloy with the specialized ability, when used for hard facing, to adhere to stainless steel and pure molybdenum. It also possesses the ability to resist oxidation at temperatures up to its melting point, and to be workable at between 150° and 350°F. Its composition is 2·5-5·5 per cent silicon, 0·75-5·25 per cent boron, and balance nickel. Where it is perhaps not so much a case of specialized application, the alloys receiving patent protection are understandably most likely to be found relying for their novelty on the incorporation of one or more of the newer industrial metals; titanium, molybdenum, zirconium, and, of course, uranium. Typically representative of this class, and one which with its wide range of composition is reminiscent of some of the very early alloys of aluminium and magnesium, is a uranium-niobium alloy, which may contain from 0·1 to 90 per cent niobium, intended for fuel elements in nuclear reactors.

# *Out of the* MELTING POT

**Some Impressions**

TO a mind still living in the good, or otherwise, old days of powder metallurgy, when the process consisted of compacting and sintering, the informal discussion on "Developments in the Practice of Compacting and Sintering," held recently by the Powder Metallurgy Joint Group, must have proved a source of slightly bewildering impressions. Having subsequently sorted them out to some extent, the individual concerned will have been left, with the impression, among others, of a most welcome interest in the mechanical aspects of these operations. In this connection marked differences in the degree of specialization are becoming apparent. Thus, while furnace builders in general, and vacuum furnace builders in particular, push on with developments in resistance, or should it be induction, vacuum furnaces, seemingly largely unconcerned with what is to be sintered, or possibly, melted in them, elsewhere the powder metallurgist, assuming the role of jack of all trades, is attempting the development of such processes as the direct rolling of metal powders from start to finish. Have, one wonders, the manufacturers of rolling mill plant yet heard of the process, or the makers of extrusion presses of the extrusion of metal powders, and, if so, what is the degree of co-operation reached between them and the powder metallurgists? It is difficult to believe that designers of such engineering masterpieces as the large continuous mills for the rolling of steel and aluminium strip will be held up for long by, for example, the limit set on the rolling speed of metal powder by the expulsion in the opposite direction of the air from the powder entering the roll gap. Another impression is of the impetus given by the exotic metals, for some of which powder metallurgy is the only means of obtaining compact metal, to the methods of producing simple shapes of large or continuous size, which methods, with a little streamlining here and there, look like spreading to the common metals, once methods of producing powders from these will have caught up bulk-wise and cost-wise with these new methods of mass processing powders. To the suggestions made regarding the possibilities of pooling certain techniques, or details of certain techniques, one would add the pooling of zone sintering (moving furnace) and powder strip sintering (stationary furnace, moving strip). Yet another impression. Considering the success of the pressureless (so-called) vacuum sintering of beryllium, to what extent is compaction really necessary, apart, that is, from satisfying such as those who enquired why no pressure had been used at some stage of producing the beryllium.

**See the Point?**

IN the removal of solids from flue gases by electrostatic precipitation the efficiency of the unit is governed by the power that can be introduced into the energizing electrodes without a "flash-over" to the collecting plates. Uneven accumulation of dust on the energizing electrodes, leading to an uncontrolled corona discharge, limits the power that can be applied, and automatic rapping of the electrodes at frequent intervals is not completely successful in overcoming this difficulty. It is now claimed that the problem has been solved by substituting for the conventional straight-wire energizer an electrode which closely resembles ordinary barbed wire. The wire is suspended vertically between the collecting plates and, although dust does accumulate on the main wire, the barb points remain clean so that the corona discharge occurs constantly at these points. By proper spacing of these barbs, complete control of the corona discharge can be achieved throughout the precipitator. It is also claimed that considerably greater power can be impressed on the energizing electrodes than on the conventional wires, thus gaining appreciably higher dust-collecting efficiency.

**More Exactly**

ONE little problem connected with the anodic oxidation of aluminium which hitherto had remained unsolved, has been that concerning the amount of ions adsorbed or absorbed by the oxide film from the electrolyte in which it was formed. A few figures, obtained by chemical analysis for, in particular, chromic acid and sulphuric acid, have been referred to here and there by one or two workers in the anodizing field, but the lack of agreement (the figures range from 0 upwards) has so far left the matter very far from certain. This outstanding little problem was one of many similar ones admirably suited to the application of the radioactive isotope technique of investigation. This has now been undertaken by two Russian investigators—A. F. Bogoyavlenskiy and A. P. Vedernikov—in the case of sulphuric acid anodizing. The 10 per cent solution of sulphuric acid used as the electrolyte contained a proportion of a 0·7 N solution of radioactive sulphuric acid containing the $S^{35}$ isotope with a half-life of 87 days. The disc-shaped (23 mm. diameter, 0·5 mm. thick) specimens of aluminium alloy sheet were anodized in the above electrolyte between two lead cathodes for periods from 1 min. to 60 min., using a current density of 2·0 amp/dm$^2$, and with the sulphuric acid at a temperature of 37°C. After anodizing, the specimens were rinsed with cold water for 1 hr. (until the wash water was free from radioactivity) and then dried between filter paper. Direct measurements of the radioactivity of the anodized surface were then made with a suitable counter tube. By superimposing an unanodized specimen over the anodized specimen, it was demonstrated that, in the case of the latter, the thickness of the metal was sufficient to absorb the beta radiation from the sulphuric acid taken up by the film on the side of the specimen remote from the counter tube. The measurements showed that the accumulation of ions of the electrolyte in the films is not connected with the growth of the film thickness. While the latter increases at first rapidly, and then more slowly with time, the concentration of sulphate (per unit weight of the film) jumped to a maximum of about 10 per cent within three minutes of the commencement of anodizing. This maximum is followed by a fairly rapid drop, the concentration reaching a steady value of about 4 per cent after about 30 min. anodizing, this value then remaining substantially unchanged during the rest of the treatment, while the film thickness continues to increase, and reaches about 8·5 microns after 1 hr. These results have been interpreted as suggesting structural incorporation of sulphate ions into the thin dense film adjoining the metal, and adsorption in the porous film subsequently formed over it.

Skimmer

PROGRESS IN HEATING FOR METAL MELTING AND THERMAL TREATMENT

# Fuel Efficiency

(*Concluded from* METAL INDUSTRY, 28 *March* 1958)

A FURTHER series of contributions to the informal discussion on "Fuel Efficiency in the Thermal Treatment of Metals" is published here. This discussion was organized recently by the Institute of Metals, and these extracts bring our report of the proceedings to a close.

## DISCUSSION

**Mr. Hughes** (Hoover Ltd.):

Can anyone present quote typical efficiency figures for a gas-fired reverberatory type furnace, with special reference to metal loss through oxidation?

**Mr. Boxall** (British Non-Ferrous Metals Research Association):

A survey covering the melting losses and the efficiencies of furnaces for melting copper alloys was made by the British Non-Ferrous Metals Research Association in collaboration with the Association of Bronze and Brass Founders. Twenty member-firms of the Research Association supplied data on their melting costs, and agreed to give reports every week and to make notes every day of their costs, split up under various headings.

This investigation showed that with the open flame type of furnace a very important point is the metal loss. If precautions are not taken and a flux is not used a very large metal loss can be incurred in melting, which can nullify all the savings made in other directions. A histogram of the results of all the rotary and reverberatory furnaces was prepared and alongside was put the cost of a loss of 1, 2, 3, 4 per cent and so on, calculated on the price of gunmetal at the time. This emphasized that a firm which makes great efforts to reduce all its costs for fuel, labour, and so on, can lose all those savings if it does not look after the melting loss.

Metal loss was not included in the figures in the histogram; it is just a theoretical calculation showing the loss in shillings per 100 lb. of metal melted for 1 per cent, 2 per cent, 3 per cent, and so on of actual melting loss; that is, the difference between the solid metal charged into the furnace and the molten metal extracted. It does not include any recovery made from the skimmings, and so on.

**A Member:** It may be correct to say that in certain cases by economizing in fuel and decreasing furnace use one may increase the metal loss and decrease the overall efficiency?

**Mr. Boxall:** That is so. This is simply a theoretical calculation for the metal loss to show how important it is compared with the other costs. It is not included in the cost figures there, but metal losses were obtained with trial melts on different types of furnace, and in the report itself actual practical figures were quoted for each type of furnace.

Generally speaking, electric furnaces are very suitable for copper alloy melting, but they do not find as much favour as might be expected. This appears to be because of the high cost of the furnaces and the high cost of the fuel. Certainly they have many advantages. The rocking resistor type of furnace is a particularly efficient one.

It was found that the melting loss for open flame furnaces could be kept down to about 3 per cent when a flux cover was used. The melting loss for electric furnaces was as good as the best crucible practice, without the use of a flux cover.

The main conclusion from this work was that if the furnace use percentage figure is very low, the foundry is probably using its plant inefficiently. Certainly if it is less than about 40 per cent it is likely that the plant is being used inefficiently, and a monetary gain could be obtained by attention to the way in which the furnace is being used.

**The Chairman:** Is this related to the size of the furnace, or to any other factors in the way that it is used? Is it too small an output for the furnace?

**Mr. Boxall:** Yes. The furnace use percentage was calculated as the percentage of the actual capacity of the furnace, and this figure can be affected by the type of casting which the furnace is making. It may be difficult to obtain a use of 90 per cent or more, but where the figure is very low, say 18 per cent, it looks as though the furnace is not being used efficiently. There is a tendency for the furnace to serve the moulder, and it would probably be better if the moulder served the furnace; in other words, when the charge in the furnace is ready to pour it should be poured straight away. This is true from a cost point of view, and also from a metallurgical point of view, because if the metal is kept stewing in the furnace it is not going to do it much good.

**The Chairman:** A big constituent seems to be the cost of crucibles. Is there any correlation between the two?

**Mr. Boxall:** There were individual differences between the different firms, and this was probably affected by the type of metal being melted in the furnace; but a low furnace use percentage will increase all the other costs.

**A. E. Mordin** (Combustion Equipment Ltd.):

Control of the furnace pressure, and whether it is in fact, and why it is, done, is of especial interest, and also the control of furnace atmosphere. Very often the furnace pressure is positive and there are huge flames blowing out of all sorts of holes in all directions. It is said that it is necessary to do this in order to control the furnace atmosphere, but there seems to be considerable variation in the performance of different types of burner (oil firing) in controlling furnace atmosphere. The specifications of various sorts of metal are steadily getting tighter, so that it is necessary to be more careful than before about furnace atmospheres. The furnace pressure has a bearing on that, because if it is necessary to maintain a positive pressure in the furnace in order to maintain the atmosphere, there is a loss of heat. If it is possible to control the furnace pressure to one's exact requirements, one is in a much better position to control the furnace atmosphere. Has anyone any comments on that?

**P. E. Servier** (Northern Aluminium Co. Ltd.):

On open-hearth aluminium melting furnaces, if the furnaces are under negative pressure and have air infiltration through the doors, the fact that flames cannot be seen coming out of the doors does not mean that the furnaces are operating efficiently, because the heat transfer rises some 5 per cent by radiation with an increase of 0·005 in. w.g. If, therefore, some flame comes out of the door, that is probably a better condition than when no flame comes out but a lot of cold air goes in.

So far as our experience of furnace pressure control is concerned, a pressure tap is taken off at hearth level and also one is taken off the stack, and, taking the mean value between the two, very little difference in melting efficiency is obtained. The furnace time is divided into two periods; a period when the furnace is melting the charge and a period when it is holding the charge at furnace temperature. There was very little rise in melting efficiency, but a considerable rise when the metal was being held at temperature prior to being transferred. The main economy arises during that period in the furnace.

**P. F. Hancock** (Birlec Ltd.):

Mordin said that he has seen a lot of flame coming out of the door. The first thing to pay attention to there is gas/air ratio control. It is no use applying pressure control until the gas/air ratio is correct. It will then be found that the benefit of pressure control will be obtained when it is applied.

**A. R. Hobbs** (South Wales Electricity Board):

At large power stations where pulverized fuel is used, if a large bulk of pulverized slag gets into the chutes there is a liability for the flame to fail, and in a very large power station this could be disastrous. There is a relatively simple differential pressure arrangement between the induced draught and the forced draught which brings an automatic oil-fired flame-maintaining device into operation. If on a huge boiler with an evaporating capacity of several hundred thousand pounds an hour this can be done satisfactorily, it should be possible on a metal melting furnace.

**A. Higgs** (West Midlands Gas Board):

The air/gas ratio must be right; but, having got that right, it is essential to work under a slight pressure at hearth level. Not an excessive pressure, but a slight pressure there prevents air infiltrating into the furnace and causing loss of efficiency. The degree of pressure depends a little on the particular furnace application. If the furnace is atmosphere-controlled, it is necessary to work to a slightly higher pressure than would otherwise be necessary, to be sure of getting no infiltration.

The suggestion that pressure outwards causes a loss in efficiency is of interest. It really depends on the furnace. If it is a recuperative type of furnace, any losses by the door may detract from the efficiency, but if the flue gases go away at furnace temperature the position is different. This idea is based on the work of Gunn at Leeds, and Professor Roberts and Anderson, who evolved a furnace technique where all the combustion products flow out through the refractories. They built a furnace with an inner refractory lining solid, and behind it they left an annular space. The combustion products are either forced to flow through the walls under pressure or made to go through under a slight vacuum. The reference books support the contention that the passage of gas through the walls is a source of heat loss, but the Papers on that subject suggest that there are grounds for reversing that view and saying that it is a source of heat gain; because the gases, instead of flowing away at furnace temperature, really supply part of the radiation losses through the walls by passing through the walls. Incidentally, about 21 of these permeable furnaces were built, of all sizes, but none has been constructed since 1951, because of the difficulty of getting permeable refractories. One supplier had difficulty with his clay sources. The original furnaces, however, are still in use and show considerable economy, even over an insulated refractory furnace of equivalent size.

The question of thermocouple coatings was raised earlier. Our sheaths are of cast iron, coated with a mixture of chromic oxide, alumina and sodium silicate, and this coating gives them a very much enhanced life.

**P. F. Hancock:** Great difficulty has been incurred in applying automatic control to electric induction furnaces for melting aluminium and certain other metals, the difficulty being due to the fact that the only material which will stand up really well to molten aluminium or molten brass is some refractory material which is fragile, so that there is constant trouble with breakage. It is sometimes possible to arrange, in an induction furnace which has a square bath, to put the thermocouple sheath in a corner of the bath, out of the way of the ham-handed man with a ladle. For aluminium, our standard practice is to use a cast iron sheath with a refractory wash, which has to be renewed every few days. Embedding a thermocouple sheath in the lining has also been tried, which is not applicable to crucible practice but is to induction furnace practice. The trouble is, however, that if the tip of the thermocouple sheath only just comes into the bath there are induction losses down the sheath, and it may read low. It may read low with sufficient consistency to enable the correct temperature to be read once it has been calibrated, or it may not. The problem is a difficult one.

**E. P. McTighe** (Regent Oil Co. Ltd.): It is accepted that a neutral or a reducing atmosphere is often desirable in a furnace when heating or reheating steel or alloy steels, and to this end there is a variety of burners available which are claimed to burn oil with a minimum of air, or in some cases with less than the theoretically correct amount. Some of these burners appear to do the job quite satisfactorily. In addition, there is the O.C.C.R. gasifier, which was mentioned earlier, which, it is claimed, can be operated with an air deficiency of 15-20 per cent. The problem when operating with a deficiency of air with a normal air burner, however, is that the temperatures required cannot be achieved.

In a textbook not long ago, a type of furnace was illustrated which would make it possible to burn oil with a 20-30 per cent deficiency of air and, at the same time, achieve the temperatures required. Has anyone had experience of this type of furnace, and, if so, what were the results achieved? The oil burner burns oil with a deficiency of 20-30 per cent air and does not achieve the desired temperature. Additional air is admitted on the right and combustion is completed. The completed combustion on the way round the inner furnace chamber transmits heat into the chamber and brings it up finally to the temperature required, the air, incidentally, being preheated.

**A Member:** It is stated that a deficiency of air makes it difficult to get the right temperature. Would Paterson, who referred to the O.C.C.R. gasifier, contend that this would better enable one to get the temperature required with a deficiency of air than would an oil burner?

**A. Paterson** (Shell-Mex and B.P. Ltd.): Both conventional oil burners and the O.C.C.R. plant use oil. The O.C.C.R. plant is very new to this country and not many have been installed here, but they can quite definitely function in a reducing atmosphere. A deficiency of 15-20 per cent is, perhaps, a little optimistic; the actual figure realized was about 10 per cent. With preheated air, temperatures of the order of 1,200°C. can be obtained comfortably.

**A Member:** With regard to furnace pressures, on reheating furnaces as distinct from melting furnaces, furnace pressure is not hard to get, but uniform temperature is. In soaking pits the bottom of the ingots cannot be heated unless the furnace has a definite pressure.

With regard to self-proportioning oil burners, for relatively low temperature work, where heat recovery is not so essential, they are ideal, but when taking all the air through the burner and having a uniform velocity up the nozzle, it is not possible to preheat the air very much. In the first place, there is a liability to carbonize the oil, and secondly, because of this pressure at a uniform velocity, there is very great difficulty if the temperature of the air changes at all; it means that it is necessary to increase the pressure proportionately to the rise in temperature. In spite, therefore, of the very great advantages of using a self-proportioning burner, it is not very practicable for high-temperature furnaces unless one can make use of the heat somewhere else.

The point about recuperation and fuel economy should be reiterated. With reheating furnaces working at lower temperatures, far more can be gained by very careful design and knowing exactly what the furnace has to do than purely by heat recovery. For example, demands are often made for furnaces to work to very close temperature tolerances, perhaps ±2°C., whereas, in fact, the previous furnaces have worked perfectly well with ±50°C. To work to these close temperature limits means a slow furnace, and probably a big furnace, with bigger heat losses and lower overall efficiency. It is important, therefore, to get the true specification worked out for a particular furnace.

**Mr. Motishead** (Kasenit Ltd.): So far as fuel efficiency is concerned, a great deal depends on the man who works the furnace. A furnace of good design may be installed and instruction given on how to work it, but as soon as you turn your back somebody comes along and alters the air/gas ratio. It is necessary, therefore, to design equipment which cannot be altered. The buyer also has to be persuaded that, although refractory bricks and insulation bricks are dear, they last a long time if left alone.

**K. E. H. Teisen** (Teisen Furnaces Ltd.): If the air is preheated on the lower heat applications, up to 20 per cent can be gained, going up perhaps to 30 per cent in the total fuel consumption on the higher heat applications. Utilizing the waste gases to preheat the combustion air is worth considering.

In the type of furnace mentioned by McTighe, presumably the reducing atmosphere which must probably be present in that furnace will assist in cutting down what might be called skin formation on billets or anything else which was being heated. This is also possible by using a gasifier unit such as the O.C.C.R. This unit may be imagined as a method of producing producer gas. The gas is fairly low in heat value; between 100 and 120 B.Th.U. If, however, it is situated close to the inlet port where the burner is, it is possible to make use of the sensible heat and go up to about 380 B.Th.U. The last application is, of course, the most practical one to use, as otherwise the heat losses would be fairly great. One must count generally on a heat loss, by using this unit, of only 5 per cent, but it is, nevertheless, there, as against using direct oil firing, which can be applied in most cases.

**The Chairman:** Reference was made a short time ago to the difficulty of getting porous refractories, but Harris talked about the difficulties of the furnace manufacturer due to the fact that the refractories were porous.

**J. C. Harris** (Birlec Ltd.): In the one case an electric furnace was under discussion where the atmosphere is air and there is nothing to be gained from the products, whereas with porous refractories it was a question of the recovery of heat from the products by giving it up to the walls and so reducing the thermal loss through the walls, which is just what the electric furnace manufacturer tries to avoid, particularly with the extremely high pressures which are being developed with forced convection circulation.

**K. E. H. Teisen:** It is surprising to hear that refractories are found to be porous, although it might have been thought the joints would be effective in that way. Is not the normal porosity (not the specific porosity) of firebricks of the order of 22 per cent, and up to 70 per cent on a refractory installation?

**J. C. Harris:** The word "refractories" was used loosely. The majority of insulations are of porous material. There are certain diatomite earths which are not so porous because they have enclosed cells which are themselves not porous, but there is a distinct porosity in insulation bricks in themselves. Refractory bricks have densities of about 130 lb/ft$^3$ and are substantially impervious. Air will, however, go through to the other side of insulation brick if an air nozzle is put up against it.

**A. Higgs:** It is a question of porosity and permeability. All the insulating refractories are porous, but the manufacturers

try to get the cells sealed in. Even with an ordinary insulating refractory there will always be some continuity, however careful the manufacturers are.

In the conventional C.C. burner, originally designed in 1944, the parallel-sided tunnel always had a ratio of 6:1. Large numbers of those burners have been sold for furnace applications. The flame combustion is completed in the tunnel and there is a very high velocity flow of gases at a high temperature from the end which sets up recirculation within the furnace. That is one reason for getting a higher efficiency, when dealing with brass billets in particular, using that type of burner.

An investigation has been carried out at Leeds to try to get greater heat releases than were possible with the parallel-sided tunnel, and this led up to the tunnel of the jet burner, working on a converging burner tunnel, the idea being that the reduced termination of the tunnel provided a stable boundary layer which retained the velocity of the flame.

Jet burners have been used in a number of applications, but there is a great deal more to be found out about them. The main applications so far in this country have been to furnaceless heating jobs, but the Americans claim to have applied burners of this type to billet heating and quite a variety of industrial processes.

**A. H. Pinder** (N.I.F.E.S.):

Ashen's figures for billet and aluminium melting furnaces seem to compare very favourably with oil-fired furnaces with cold combustion air. It is well known that by preheating the combustion air it is possible to save 20-30 per cent of the fuel. Has any work been done with concentrated combustion burners with preheated air, because the choice of refractory is rather a formidable one? A good deal of work has been done on concentrated combustion, both with gas and with liquid fuels, and it has been found with oils that the choice of a refractory which would stand up to the temperature, erosion and thermal shock was quite a difficult one.

**The Chairman:** Some experimental work is being done on the methane-acetylene version, using methane-oxygen mixtures pre-heated up to about 500°C. each before mixing. These work at temperatures in the region of 1,800°-2,000°C. in a tunnel burner of somewhat special construction, but the point is that sintered rings are being used which are extremely good against thermal shock. It is an expensive method, but quite accurate sintered rings can be made. It is difficult to say what life will be obtained from them, because they are still in the experimental stage. They have been used for a considerable length of time, but we are always changing the conditions and starting again, so that it is difficult to say what the life is. The conditions are very severe.

**A Member:** There was a furnace at the B.I.F. which used preheated air.

**A. Higgs:** That furnace was built by the Incandescent Heat Company, and had a zircon lining imported from the U.S.A. In general, on the concentrated type of combustion burner there is no air preheat. There are exceptions; a German firm has recently installed in this country several furnaces for operating on a cycle up to 1,800°C. with four C.C. burners with air preheat up to a maximum of 800°C., with multitubular recuperators.

**K. E. H. Teisen:** The fused zirconium oxides were almost prohibitive in cost for normal applications, but they are promising. Zirconium silicate has also been considered for some purposes, but, unfortunately, it can spall, and it is not so good as the zirconium oxides. There is also fused alumina, which can be used for exposed burner parts and which has been used in one or two cases. Continuing downwards, the material most frequently used nowadays is mullite. Mullite burner blocks are used for oil and gas burners, and are found in all sorts of burners. The life is difficult to give because it varies a great deal, but a good block should last six months, and the construction should be such that it can be taken out and replaced without difficulty.

Coming back to the burner construction proper and the question of how much combustion air is passed through the burner, some of the preheated air can be sent through the burner, preheated to about 300°F., which is about the maximum, and then, after the burner, a further amount of secondary air, well preheated, can be introduced, and there is sufficient jet momentum from the burner proper to get a good mixture.

**F. C. Ashen:** There has been reference to reducing atmospheres of 20 per cent and 10 per cent, but usually, in any industrial furnace, it is neutral; if there is a reducing atmosphere, a very small percentage of CO and a little hydrogen will suffice. If there is a reducing atmosphere and that atmosphere is escaping up the flue, the small amount of combustible in the gas will far outweigh anything that could be lost with excess air. The furnace could be swept clean with excess air and still not lose as much heat as is lost with 20 per cent of reducing atmosphere.

Some remarks were made about the difficulty of maintaining a proper standard of control on equipment. The non-ferrous metals industry has a tradition of knowing its fuel, and the old-type operators could not carry out their operations until they appreciated the fuel factors. In the old days, a man would stand by the furnace all his life; it would be *his* furnace, and no one else would be allowed to go near it. During the war that started to change. The type of furnace changed, and instrumentation was one of the causes of deterioration in operation, because the sales talk was that with instrumentation it was possible to use unskilled labour. The fact is, however, that with instrumentation more intelligent people are needed to work it; but very often the crews of furnace equipment were downgraded.

In most thermal processes a figure of 20 per cent would be putting efficiency high. There are examples of electric furnaces of over 50 per cent, and of new types of gas furnace which are inherently designed to take advantage of all the fundamental factors which should be built into a furnace. They are planned between the production man, who knows what he wants, and the furnace man, who knows how to build it. If it is inherently efficient in design it cannot go far wrong, but if it is not it can never be right. No amount of damper controls or pressure regulation or anything else will make an inefficient furnace efficient.

The chairman then expressed thanks to Mr. Ashen and Mr. Hancock for their introductory addresses, and also to the Principal of the Birmingham College of Technology, Dr. Venables, for the use of the hall and the other facilities. The meeting was then closed.

# Men and Metals

A new appointment recently announced by Metropolitan-Vickers Electrical Company Limited is that of **Mr. N. R. D. Gurney,** A.C.G.I., M.I.E.E., to be sales manager of the plant department. Formerly chief engineer, electrical general engineering department, Mr. Gurney succeeds **Mr. R. J. Cochran,** who is seconded to special duties.

It is announced that the Council of the Iron and Steel Institute has made the following awards for 1958:—Bessemer Gold Medal to **Mr. W. F. Cartwright,** of the Steel Company of Wales Limited; Sir Robert Hadfield Medal to **Mr. W. C. F. Hessenberg,** of of the British Iron and Steel Research Association; the Ablett Prizes for 1957 (£50 each) to **Mr. C. E. H. Morris** and **Mr. R. N. Dale,** of the Steel Company of Wales Limited, for their Paper "Planning the Conversion of a High-Lift Slabbing Mill to a Universal Mill."

At the recent annual meeting of the Midland Scrap Iron, Steel and Metals Association, **Mr. E. W. Pugh** was elected President in succession to **Mr. G. Aymer Barrow.**

London manager of the Incandescent Group of furnace engineers, Smethwick, **Mr. George Wright** has left for an extended market investigation in India. The Incandescent Group has a long association with India, and Mr. Wright will report on new openings for capital goods in what is a rapidly expanding market.

Announced recently by Metropolitan-Vickers Electrical Co. Ltd. is the appointment of **Mr. O. T. Evans,** Assoc.M.C.T., A.M.I.Mech.E., A.M.I.E.E., as chief engineer, electrical general engineering department. This department comprises the mining and rolling mill divisions.

Albright and Wilson Limited announce the appointment of **Mr. Forrest F. Musgrave,** D.Phil., F.R.I.C., as personal assistant to **Mr. Sydney Barratt,** chairman of the Albright and Wilson group of companies. Dr. Musgrave was formerly managing director of Lubrizol Great Britain Limited.

At the annual dinner of the Birmingham Metallurgical Society, held last week, presentations were made of the students' essay prizes, the recipients being **Mr. John C. Martin** for his Paper on "Modern Developments in Steelworks Gas Producer Practice," and to **Mr. John G. Outhwaite** for his Paper on "Fundamentals of Gas Release from Liquid Metals."

PROCESS FOR REMOVING OXIDE DEPOSITS AFTER HEAT-TREATMENT

# Electrolytic Descaling of Titanium

ESPECIALLY useful in removing heavy oxide deposits after titanium is heat-treated, without involving costly inert-atmosphere processing facilities, a process for electrolytic descaling is lowering processing costs and minimizing rejections at Delco Chemicals Inc., Los Angeles.

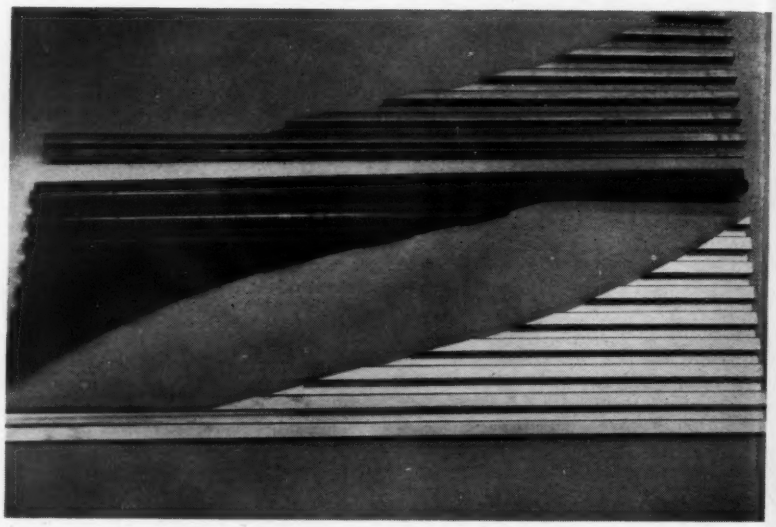
At least three other methods have previously been used to descale titanium. They necessitate respectively the usage of nitric-hydrofluoric acid baths, molten salt baths, and abrasives.

As the action of a nitric-hydrofluoric acid solution is greatly retarded by oils, greases, stamping inks, and many other materials employed during the fabrication of titanium parts, appreciable manual cleaning effort is required prior to the use of an acid bath. Moreover, due to variations in oxide thickness caused by uneven heating, severe etching and a reduction in thickness have occurred where no special provisions could be made for short-time immersion and subsequent hand scrubbing with steel wool. Consequently, parts formed with closed angles or with areas inaccessible to hand scrubbing could not be completely descaled.

The molten salt method involves the use of a dispersion containing salts of alkali metals, heated and maintained at a temperature above 370°C. (700°F.) (usually 430°C. to 480°C.). Close temperature control is essential, since a bath too cool reduces the descaling reaction rate. Titanium parts descaled in molten salt baths are customarily discoloured upon removal, and require additional chemical treatment for cleaning and brightening. This chemical treatment usually involves use of a sulphuric acid bath, after which parts must be immersed in a nitric-hydrofluoric acid bath. Therefore, disadvantages of the molten salt method include high original cost, high operational cost, close temperature requirements, and the need for supplementary processing.

Abrasive methods of removing oxides (frequently employed on forgings or heavily-scaled parts) include grit or vapour blasting and grinding. All produce a matte or scratched surface, and often a discoloured appearance.

The electrolytic process is said to eliminate the main disadvantages of previous methods by completely removing oxide scale from titanium surfaces without materially reducing metal thickness or severely etching exposed component surfaces. It consists briefly of using a titanium article as a cathode in an electrolytic bath which may have either a ferrous metal or titanium anode (the latter being preferred). Direct current with an electromotive force of 6 to 36 V. may be passed between the anode and cathode, and the polarity of the electrodes may be reversed for periods of two or three minutes to accelerate the removal of oxides.



*Corrugated titanium panels before and after electrolytic descaling*

The electrolyte is used at ambient temperature and consists of: hydrofluoric acid (48-70 per cent), 1 per cent by volume; nitric acid (38°-46° Bé.), 4 per cent by volume; sulphuric acid (60°-66° Bé), 20 per cent by volume; water, 75 per cent by volume; ferrous sulphate or aluminium sulphate, 3-5 oz/gal. of other ingredients.

The time required for descaling a given titanium article is variable—depending on current density, oxide scale thickness, and bath concentration.

When a part appears to be free from scale, it is disconnected from the current source, removed from the electrolytic bath, and rinsed in running water.

Titanium parts not completely freed from scale after the running water rinse may be returned to the electrolytic bath until a clean, bright, oxide-free surface is obtained.

Besides eliminating the need for expensive heat-processing equipment and allowing one man to accomplish tasks that formerly required the services of eight employees, the new process virtually eliminates rejections due to uneven etching; for its etching action is so delicate that machining marks are frequently visible on titanium components which have been descaled for periods ranging up to 1 hr.

The latter phenomenon is partly attributable to the use of sulphuric acid and sulphates which inhibit the reaction of the electrolyte on titanium, and thus prevent the formation of black smuts after oxides are removed.

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# Metal Spraying

COMBINING the economy of ordinary tube rod with the advantages of solid wire, an improved method of producing hard-facing alloys in coil form has been introduced in the U.S. by the Union Carbide International Company. A more compact rod is produced by drawing down or compressing the diameter of a tube rod to standard wire sizes and tolerances.

Called a drawn tube rod, four advantages are claimed for it. These are: — The rod is easy to apply; it requires no nozzle changes or adjustments in feed-roll pressure when changing from solid build-up wire to hard-facing rod. It gives a deposit comparable in smoothness to a solid-wire deposit, and the deposit is uniform in hardness over the entire hard-faced area. Parts protected with the drawn tube rod are estimated to last 30 per cent longer than new ones. The rod costs no more than ordinary tube rods that are not drawn, yet it is easier to handle.

The drawn tube rod is available in six alloys, ranging from very hard and abrasion-resistant to tough and shock-resistant, designed to withstand many different operating conditions.

**Finishing Supplement**

# Chelating Agents

## THEIR VALUE AND APPLICATIONS IN METAL FINISHING

By D. J. FISHLOCK

ONE of the latest and most fascinating of the ever growing host of mysterious "fauna" known as addition agents, which play so vital a role in contemporary finishing practice, is the chelating agent. A feature of metal finishing practice which is only lately becoming fully appreciated and studied is that of the contamination of solutions by soluble impurities, particularly metal ions, and the elimination or suppression of such contaminants. In electroplating the effects of stray metals, such as copper, lead and zinc in nickel solutions have long been recognized and methods for their elimination worked out. Only recently, however, has attention been turned to other plating, chemical treatment and cleaning solutions, but the results are most encouraging. In addition, the methods of suppressing the impurities by complexing them has led to striking improvements in many almost unrelated facets of metal finishing practice.

Basically there are three mechanisms available for inactivating undesirable ions. These are:—

(a) Complexing: the formation of complexes with any type of metal ion. Strictly speaking, this embraces (b) and (c).

(b) Sequestration: sequestering agents have the ability to form soluble complexes: in a literary sense the word implies confiscation or seizure.

(c) Chelation: chelating agents inactivate metal ions by combining to enclose them in an inner ring structure. A soluble complex of this type is much the most serviceable.

The best known sequestering agents are the polyphosphates, e.g. sodium hexametaphosphate (Calgon), these being widely employed in alkaline cleaners to complex the calcium and magnesium ions. Hydroxy acids such as citric, tartaric and gluconic acids have also proved of value in specific instances, while the complexes formed between nickel and glyoxime, and between ferric iron and "cupferron" are well known to the analyst. These latter are actually themselves chelate compounds, but the primary concern of this article is with chelating agents of the aminopoly-carboxylic acid type, such as ethylenediamine tetra-acetic acid (E.D.T.A.) and its salts.

Known to pure scientists for many years, the bulk of the applied literature on chelation dates only from about 1950, but in metal finishing the scope thus far revealed augurs well for the future. The chelate compounds exhibit a very strong sequestering power, and in addition are often highly stable, in comparative extremes of temperature and pH—in contrast to the polyphosphates which break down in hot solutions. The complexing action of the chelates is very rapid and once complexed, the undesirable metal is rendered chemically inactive by an effectively irreversible reaction. This leads to an impressive variety of now established applications in metal finishing, viz:—

(a) In plating and related solutions for suppressing the effects of trace metals.
(b) For complexing dissolved metals in cleaners, and also as a detergent and etchant in its own right.
(c) In the preparation of plating solutions as an alternative to cyanide; particularly useful for alloy plating.
(d) In the rapid volumetric analysis of plating solutions.
(e) In anodizing solutions to prevent metals imparting a tint to the oxide film.
(f) For reducing hardness of rinse waters.
(g) In polishing and barrel tumbling media.
(h) In the formulation of immersion plating solutions.
(i) In chemical plating solutions.
(j) In paint formulations.
(k) As a special cleaner for decontaminating radioactive surfaces.

Commercially E.D.T.A. is available as a series of salts which increase in solubility with increasing metal content (Table I). The acid itself is a colourless, crystalline solid which decomposes at its melting point of 240°C. Sequestrol, one proprietary form, is also available as a liquid to facilitate its measurement and addition to vats, for example.

**TABLE I—E.D.T.A. SOLUTIONS SOLUBILITIES AND *p*H VALUES**

| | 22°C. | 40°C. | 80°C. |
|---|---|---|---|
| Ethylenediamine tetra-acetic acid | 0·2 | 0·2 | 0·5 |
| Monosodium ethylenediamine tetra-acetate | 1·4 | 1·4 | 2·1 |
| Disodium ethylenediamine tetra-acetate | 10·8 | 13·7 | 23·6 |
| Trisodium ethylenediamine tetra-acetate | 46·5 | 46·5 | 46·5 |
| Tetrasodium ethylediamine tetra-acetate | 60·0 | 59·0 | 61·0 |

### Metal Cleaning

The basis of this application of chelates is that, with the single exception of sulphides, E.D.T.A. solutions will dissolve to some extent all of the usual water-insoluble corrosion products—phosphates, oxides and hydroxides, carbonates, sulphates, etc. The salt can be used alone in hot weak solution (e.g. 1 per cent of the tetrasodium salt). This yields an effective mild cleaner capable of removing very light grease and corrosion, and quite without attack on all metals except magnesium and aluminium. The latter may be slightly etched under some circumstances, but the attack is completely inhibited by adding a little silicate to the solution; magnesium, however, is rapidly attacked and cannot normally be treated. Such a solution can also be used as a rinse to eliminate the siliceous films which sometimes develop on metal being cleaned in hot metasilicate prior to plating.

More generally applicable, though, are the alkaline solutions which incorporate chelates at some 1 to 5 per cent concentration. These are of two types. One is the normal alkaline degreaser wherein the chelate supplements the normal grease-removing mechanisms of emulsification, peptisation and saponification by both helping to dissolve the otherwise often insoluble corrosion deposits and by preventing the precipitation of films like the siliceous ones, and calcium and magnesium soaps, which interfere with the adherence of electrodeposits. In such solutions they replace such additions as cyanides and polyphosphates, both of which break down at high temperatures. Except with light alloys the influence of the chelate is confined to the region between the metal and deposit, and deposits tend to flake away rather than dissolve. Even such notoriously difficult contaminants as decomposed organic matter and fluxes are removed by these media. The solutions can be used as immersion cleaners, but greater efficiency is achieved by electrolytic treatment.

The second type of treatment is the alkaline derusting solution. Alkaline derusters have salient advantages over their acidic counterparts—chiefly in respect of the absence of attack on the base metal and the elimination of the effluent disposal problem. They are highly caustic solutions, many of which incorporate fluorides and cyanides to effect the dissolution of corrosion products. Here again chelates offer an equally efficient and more stable, non-toxic alternative. While alkaline E.D.T.A. solutions will not dissolve

TABLE II—PREFERENTIAL ORDER OF CHELATION

| *p*H | Element |
|---|---|
| 4·00 | Chromium, copper, nickel, lead, cobalt |
| 6·50 | Nickel, copper, cobalt, zinc, calcium |
| 8·65 | Nickel, cobalt, copper, zinc, calcium, magnesium, strontium, barium |
| 11·00 | Cobalt, nickel, copper, zinc, calcium, magnesium, strontium, barium |

rust and scale alone, by combining E.D.T.A. with cyanide in strong alkali a solution capable of dissolving both rust and mill-scale is prepared. Alternatively the E.D.T.A. can be combined with a hydroxylic chelate to give a solution capable of dissolving rust only, but which can be quickly regenerated by "plating-out" the chelated iron.

Special types of deposit which are removable by alkaline chelate solutions include organic finishes, boiler scale, and chromate and phosphate coatings. Of especial interest for the latter is a solution which has been investigated in the U.S.A. for removing phosphate coatings without attacking the base metal. This comprises: Sodium cyanide 90 gm/L.; Sodium hydroxide 180 gm/L.; and E.D.T.A. (Na salt) 90 gm/L. Manganese coatings need cathodic treatment at 70°C., but zinc and iron coatings are removable in 10 min. at room temperatures.

Another specialized cleaning operation for which chelates have proved effective is the decontamination of radioactive surfaces. In 1 per cent solution they have been successfully used to remove $Ba^{140}$ from both metals and non-metals, while the non-metallic $P^{32}$ has been cleansed from Lucite. Their scope in this sphere, though, is very much a matter for individual tests, while chelation, of course, in no wise lessens the ratioactivity and the detergent must still be disposed of.

## Metallic Impurities

The adverse influence of traces of heavy metal ions in many electroplating solutions has long been appreciated, and in most cases effective methods, such as the "dummying out" procedure for nickel solutions, are available for their elimination. Of greater interest, though is the possibility of inactivating these impurities instead of removing them. Chelates have proved compatible with many plating electrolytes, and the recommended addition of E.D.T.A. is about six times as much as the weight of impurities present. Illustrations of its application include cadmium baths, where lead, antimony, arsenic, tin, silver, copper, and thallium all cause troubles, zinc solutions where copper and lead affect the deposit, cyanide copper solutions where iron reduces the cathode efficiency, silver baths where iron yellows the plate and most troublesome of all, nickel solutions.

The latter present a particular problem in that they are inordinately sensitive in this respect, but organic contamination is equally obnoxious. Organic impurities usually lower the ductility and increase the internal stress of the nickel deposits, and if chelates are added to the solution the deposit formed must be sufficiently ductile to absorb the additional stresses induced without cracking. Watts-type solutions can normally be purged of iron, copper, lead, zinc, etc., by chelates, but the inherently poorly ductile bright deposits, which are even more sensitive to these metals, are more allergic. In these, chelates tend to produce a highly stressed and unsatisfactory plate. However, it has, on occasion, been found possible to use them in this capacity, more particularly in the more ductile semi-bright deposits.

A cautionary note on the use of chelates for complexing is needed, though, since occasionally a small amount of another metal may be deliberately added, either as a brightener (e.g. selenium, cadmium, zinc, in nickel solutions), to whiten a deposit (e.g. molybdenum, aluminium, in zinc solutions), or to tint a deposit, (e.g. silver, cadmium, copper, in gold solutions).

Similarly, in anodizing electrolytes metallic contaminants such as iron, lead, and copper, and alkaline earths such as calcium and magnesium tend to interfere with the tint and the colouring propensity of the anodic film, and make dyeing to the more delicate pastel shades rather difficult, as well as producing an uneven or spotty colour. Heavy metals also markedly affect many dye-solutions by forming complexes or insoluble agglomerates. Affected dyes include Polar Red G, Diphenyl Red B, Eriochrome Orange R, Solophenyl Turquoise Blue GL, Diphenyl Brilliant Blue FF, Niagara Direct Blue RW, Direct Erie Green GY and Acid Yellow T. Care is necessary in this case, though since many organic dyestuffs are themselves metallic complexes, among them dyes of the Neolan and Palatine type, and chelates will interfere with the dye itself in such cases.

This field at present is largely unexplored and undoubtedly the addition of chelates to solutions of a more ephemeral nature will also become standard practice in future. An example is with chemical colouring solutions where very little work has been done on the influence of impurities since these are normally discarded as soon as they give trouble. Rinse waters, too, can be effectively softened by their use, while by combining E.D.T.A. with hexametaphosphate the influence can be further enhanced while hydrolysis of the latter is retarded. A small addition of E.D.T.A. to the final post-plating rinse will prevent water-stains from forming. A guide to the preferential order of chelation for solutions of varying *p*H is given in Table II.

## Complex Plating Solutions

The advantages of electroplating from solutions of complex metal ions, in which the actual free ion concentration is very low, are manifold; chiefly, however, such solutions give deposits of finer crystal structure, smoother aspect and better distribution. The principal complexing radicle has long been cyanide, which, notwithstanding many attractive features, is highly toxic and presents a considerable toxic hazard. Latterly other radicles are gaining favour, among them E.D.T.A. complexes. For alloy plating the differences in deposition potential between copper and zinc, for instance, can be greatly reduced, and the same applies to many other alloys. Gold alloy plating from an E.D.T.A. solution is currently being conducted on mass production of ornaments and jewellery. The process is stated to have excellent throwing power and solution stability while make-up water need not be distilled. Single metals, too, notably nickel[1] and iron have been plated successfully from such solutions, and it does appear that the inevitably comparatively high price of the chelates is the restraining factor for much wider use.

A recommended nickel solution[1] contains nickel sulphate 100 gm/L.; sodium citrate 66 gm/L.; sodium or ammonium chloride 35 gm/L.; E.D.T.A. 20 to 100 gm/L.; triethanolamine 35 to 50 c.c/L.; nickel nitrate 10 to 30 gm/L.; sodium bisulphate 3 to 8 gm/L.; *p*H, 6·5 to 12, current density, 40 amp/ft², temperature 60°C.

One unique feature is that by varying the *p*H and thus the free metal ion concentration, close control of throwing power can be achieved. The deposition of one alloy, the now well-established 75 per cent tin: 25 per cent zinc plate, from a chelate complex solution has been studied. The original solution was based on cyanide, but old solutions have been found to have accumulated formate and carbonate from its decomposition. These are thought to cause the irregular anode dissolution reported in well-worked baths. A solution containing the following constituents was evolved: sodium stannate 70 gm/L.; zinc 1·0 gm/L.; sodium hydroxide 5·0 gm/L.; complexone solution 80 mL/L; current density 20 Amp/ft²; temperature 70°C.

The complexone solution is used at a concentration of 1 gm mole per litre *N*. hydroxyethylenediamine triacetic acid (trisodium salt), (i.e. E.D.T.A. with one acetic acid group replaced by hydroxyethyl).

Again, immersion plating solutions based on chelates offer the same advantages regarding both stability and the quality of the plate. A solution suggested for producing a bright, adherent copper deposit 0·00002 in. to 0·00003 in. thick on ferrous work comprises: sequestrol copper complex

100 gm/L.; sodium lauryl sulphonate 0·5 gm/L.; *p*H 4 to 5; temperature ca. 50°C.

Another German formulation is given as: copper sulphate 37·5 gm/L.; E.D.T.A. 97·5 gm/L.; wetting agent 0·5 gm/L.; *p*H 4 to 5; temperature 40° to 60°C.

Such a solution gives a deposit suitable for bronzing, oxidizing, etc., and also as a drawing lubricant; it is, however, unsuitable as a basis for an electrodeposit.

Recently catalytic chemical plating by reduction has attracted much attention, since it combines many of the advantages of electrodeposition with the infinite throwing power of non-electrolytic processes. Most publicity has attended the chemical deposition of an alloy of some 93 per cent nickel, 7 per cent phosphorus, but alloys of cobalt, and both cobalt and nickel with phosphorus are also obtainable, while it is currently rumoured that the plating of gold and chromium alloys (among others) in this way may also become practicable.

The earlier essentially simple solutions for chemical plating proved inherently metastable and were inclined to decompose completely and irretrievably, and without warning. Development work evolved much more complex baths wherein essential stability was achieved with a diversity of additions, prominent among which were chelates. The aim in these solutions, in which deposition arises from the reduction of a nickel salt by hot hypophosphite solution, is to prevent the precipitation of insoluble phosphides. If precipitated, these act as catalytic nuclei for the deposition of nickel within the solution, and hence its rapid and total decomposition. The limit of solubility of nickel phosphide is very low, but can be considerably increased by incorporating a stable nickel chelate complex. The stability of the complex is of especial significance here since an unduly stable one can prevent plating; however, further additions, termed "exaltants" can be used to counter any reduction in speed of deposition.

### Plating Analysis

Metal finishing solutions are subject to a progressive change in composition —very often even when not actually being worked. The prime requisite of analytical methods for these solutions must perforce be speed, combined with reasonable accuracy. Physical methods apart, the most rapid analytical techniques are the volumetric ones and their essential simplicity renders these even more suitable for workshop control.

In this sphere the role of chelates derives from the very abrupt cation concentration change which can be detected either by potentiometric or indicator methods, the end-point being particularly distinct and thus aiding relatively unskilled analysts.

The chief application is for the determination of the principal metal(s) in a plating solution. For instance, nickel can be determined in the nickel bath by the following method:

(a) Pipette a 2 mL. sample into a 250 mL. conical flask and add about 100 mL. of distilled water.

(b) Add 10mL. of ammonia (0·880).

(c) Add about 2 gm. of Murexide Indicator.

(d) Titrate without delay, until the colour changes to a light-brown to violet shade, with standard E.D.T.A. solution (216 gm/L. of diosodium ethylenediamine - tetra - acetic acid dihydrate, i.e. 0·0575 M. solution; mL. $\times 1{\cdot}69$ = gm/L. nickel.)

Equally rapid methods are available for copper, zinc, cadmium, in their respective solutions; copper and zinc in brass solutions; in all of these cases titration with 0·0575 Molar E.D.T.A. follows destruction of the cyanides by acid treatment. The determination of magnesium in nickel solutions has been described, while the traces of many metals in effluents, etc., can be assessed in this way. Water hardness titration with E.D.T.A. is another use. Calcium and magnesium form soluble wine-red complexes with Erichrome Black T (Solochrome Black WDFA), at *p*H 10, but are readily extracted from the complex by the chelate with a colour change to blue; this gives a method more rapid and accurate than titration with standard soap solution, while it is extremely sensitive and particularly recommended when the hardness is below 1 part per 100,000.

### Miscellaneous Applications

Other applications include incorporation in paints. Here it can prevent the discoloration which arises in casein paints due to reaction between metals such as iron and the protein; it also retards paint decomposition. In emulsion paints it aids stability by complexing the traces of cadmium and magnesium which can otherwise cause reversion when hard water is added. In some synthetics too, heavy metals affect the ageing properties and these can be similarly suppressed.

Practical applications include the use of chelate solutions for cleaning paint brushes and spray guns, while paint stripping as already noted, is rapid in hot alkaline chelate solutions.

E.D.T.A. has also been incorporated in polishing compounds probably with a view to expediting the subsequent removal of the compound in the cleaning bath. A suggested formula comprises: soap 12, tripoli 25, kieselguhr 30, rouge 6, water 22, E.D.T.A. (tetrasodium salt 50 per cent w/v solution) 2. It is also used in barrel finishing media to aid tarnish and grease removal.

The author would like to acknowledge the assistance of The Geigy Co. Ltd., in the preparation of this article.

### Reference

[1] U.S. Pat. 2,773,818.

# Correspondence

*Correspondence is invited on all subjects of interest to the non-ferrous metal industry. The Editor accepts no responsibility either for statements made or opinions expressed by correspondents in these columns*

TO THE EDITOR OF METAL INDUSTRY

## Vapour Plating of Nickel

SIR,—While appreciating the work put into the preparation of the Paper on Vapour Plating of Nickel, by Mr. L. W. Owen, I fail to comprehend the value of the energy expended.

If, as stated, the quality of the deposits is roughly comparable with that produced by the Watts type electrolytic bath, and the rate of deposition is approximately the same, then surely the cost of production must be very much higher owing to the expensive equipment required.

Further, the process seems to require a very high order of skill at a presumably high rate of remuneration compared with the normal run of wages payable in the electrodeposition trade. It would also seem that a very limited degree of flexibility as to size and shape of component is acceptable without special plant.

Surely the expenditure of time, money, and above all, high academic attainment could with greater advantage, be used in directions showing a greater likelihood of commercial return?

Yours, etc.,

**H. A. Matt.**
*Managing Director.*
The City Plating Company Ltd.
David Road,
Coventry.

# Publications Received

A COMPREHENSIVE report on "Properties of Wrought and Cast Aluminium and Magnesium Alloys, at Room and Elevated Temperatures" has been prepared by Bristol Aero-Engines Ltd. and is published for the Ministry of Supply by Her Majesty's Stationery Office. This report details a comprehensive series of tests, providing very full documentation and tabular matter on tests of fatigue, creep, tensile strength, expansion, thermal conductivity, hardness and metallography.

THE March issue of "I.C.I. Pretreatment News" contains articles on the elimination of steam and fume from chemical processing baths, and on phosphating pretreatment for tube drawing.

THE latest issue (No. 5) of the "Inco-Mond Magazine" contains a review of the Canadian nickel industry, and includes articles on the production of hard nickel dies, stainless steel piping, and food manufacturing equipment, S.G. iron valves, rhodium-plated tableware, and certain Swedish enterprises. A description of the use of cobalt in Irish sheep farming strikes an unusual note in such a publication.

# Standard Specifications

*Anodized Aluminium* (*B.S.*1615 : 1958). *Price* 7*s.* 6*d.*

THIS revision of B.S.1615 : 1949 brings the methods of test into line with current practice, and includes requirements for additional properties. Further, the method of expressing the grade of material for specular reflectors for white light has been altered in order to make the standard more widely applicable.

The abrasion test has been revised in the light of past difficulties experienced in its operation; and the dimensions of the test jet have been more closely specified. The Bengough-Stuart chromic acid anodic film has not been found a suitable standard for comparison of coatings produced in sulphuric acid, nor has it been possible to find any other suitable standard specimen. The present test is, therefore, only comparative, and identical results may not be obtainable on different pieces of apparatus. Work aimed at improving the reproducibility of the test is continuing, and users are invited to communicate their experiences to B.S.I.

The publication deals with the following properties:—thickness; specular reflection factors; diffuse reflection factor; infra-red reflection factors; resistance to abrasion; colour; fastness to light; resistance to leaching; resistance to stains; breakdown voltage.

*Gas Meter Unions and Adaptors* (*B.S.*746 : 1958). *Price* 5*s.*

A REVISION of the British Standard prepared in 1937, which, in turn, was based on a specification issued in 1902 by the Board of Trade, this standard embodies the following changes: the inclusion of requirements for unions of 2 in. nominal size, and of tables of dimensions for adaptors and adaptor washers; in addition, slight alterations have been made to the limits for screw threads—but they will not affect interchangeability between parts produced according to the 1937 edition and this new one.

Following the specification for materials and screw threads are ten dimensional tables relating to bosses, nuts, liners, adaptors and washers; eight of them are displayed in conjunction with fully annotated diagrams.

There are two appendices. They deal with "Nominal sizes" and "Method of test for the flexibility of rubber material."

*Glossary of Terms Used in High Vacuum Technology* (*B.S.*2951 : 1958). *Price* 7*s.* 6*d.*

IN any rapidly growing branch of technology there is need for guidance in the use of approved terms and their concepts. The purpose of this new British Standard glossary is to define the terms of accepted value in the many branches of science and industry where high vacuum technology has become important.

The glossary differs in detail from its "opposite number" in the U.S.A., but every endeavour has been made to ensure that, as far as possible, the same term is used with the same meaning in the two countries. Where a number of terms with approximately the same meaning have come into use, those preferred have been selected for definition.

The glossary is arranged in sections, dealing separately with general terms, vacuum systems, pumps and pump components, manometers and gauges, leak detectors, and vacuum applications; the last-named section contains terms relating to well-known vacuum processes, including electrical and valve manufacture.

Comprehensive notes on pressure units, critical backing pressure and sensitivity definitions in leak detection are given in an appendix.

The new publication contains a list of the symbols and abbreviations used within its 26 pages; and ends with a detailed index to the terms defined or discussed.

**Copies of these standards may be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London, W.1.**

# Induction Melting

AVOIDING the limitations of both mains frequency and high-frequency furnaces, a coreless high-frequency melting unit which obtains the requisite frequency conversion by using glass bulb mercury arc rectifiers, has been produced by the collaboration of two firms—Metalectric Furnaces Limited, Smethwick, and Hackbridge and Hewittic Electric Co. Limited, Walton-on-Thames. This furnace is about the same in capital cost as mains frequency plant, and, therefore, costs less than the motor alternator. No special foundations are needed since the only moving parts are the small cooling fans for the rectifier bulbs. This is reflected in reduced maintenance time and long, trouble-free operation. A further advantage is that the conversion efficiency of the mercury rectifier is higher than the motor alternator. Unlike traditional equipment, there is no capacitor switching, since changes in the load during the melting are reflected in the generator, and cause automatic adjustments of the frequency.

The equipment will withstand heavy overloads without damage. Constant use causes no alteration of conditions within the bulb, which is entirely pumpless. Nothing is consumed in the process of conversion—there are no igniters to renew or anodes which require changing.

Control and metering is arranged on the front panel of the convertor cubicle. Operation of the furnace is very simple: all that is necessary is to press two push buttons, the first to close the circuit breaker connecting the equipment to the three-phase supply, and the second to switch on the high-frequency current.

The new equipment is fully developed for ratings up to 100 kW, and is suitable for all ferrous and non-ferrous metals. Sizes above 100 kW are in advanced stage of development.

*The Metalectric-Hewittic 50 kW induction furnace 120 lb. capacity pouring mild steel*

# New Plant & Equipment

## Humidity Testing

THREE larger models of their series HTC humidity test cabinets have been introduced by Barlow-Whitney Ltd., 2 Dorset Square, London, N.W.1.

The new units are catalogued under references HTC 5, 6, and 7, and the respective internal dimensions are 36 in. wide by 36 in. high by 36 in. deep, 54 in. wide by 36 in. high by 36 in. deep, and 72 in. wide by 36 in. high by 36 in. deep. Like the smaller models they incorporate highly accurate yet flexible control of both temperature and humidity.

The cabinets are entirely self-contained units with clean external lines, and only require connection to electrical and water services, and provision for drainage. The interiors are constructed from heavy tinned copper which has excellent thermal and corrosion resisting characteristics.

The "rapid response" humidifier is arranged for easy inspection, and particular attention has been paid to the air circulator in order that uniform distribution of temperature and humidity prevails under all conditions.

The control system comprises adjustable electric thermometers, relays and input regulators catering for dry heat temperatures from ambient to 100°C. Relative humidity conditions from 40 per cent to 99 per cent can be produced with temperatures to 70°C. Provision is also made for controlled cyclic temperature variation under damp heat conditions, adjustable for both amplitude and frequency.

Other features include large viewing windows, interior inspection lighting, and conveniently located holes for test leads which can be sealed effectively by rubber inserts when not in use. Strong wire mesh or special trays are supplied to requirements.

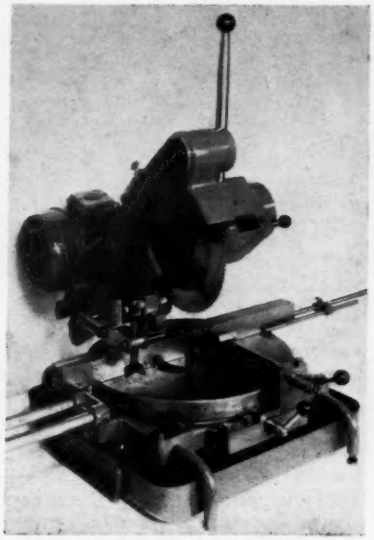
## Sawing

EXTREME accuracy and burr-free finish are claimed as being among the advantages offered by the Ulmia circular sawing machine. This machine is of higher power than the standard machines, and three models are available, including one for non-ferrous metals and another for non-ferrous metals and steel.

The large round table, providing ample support for the workpiece, is mounted accurately on a ball-bearing foundation plate, and carries a swivelling twin arm serving as a motor support bearing for the saw shaft and protection for the saw blade. The swivelling arm is carefully counterbalanced and allows for the downward advance of the saw blade by means of a manually-operated lever.

The round table, together with the twin arm, can be swivelled on its ball-bearing foundation plate to both sides to any desired angle between 0° and 50°, by means of a very clear vernier scale which can be set and locked in position by a crossbar.

Two well-dimensioned robust fences make it possible to place the workpiece firmly in the right position. The clamping device consists of an all-round adjustable clamping spindle with a notched tension lever and a movable ball-mounted indented V-shaped thrust plate.



*The Ulmia circular saw*

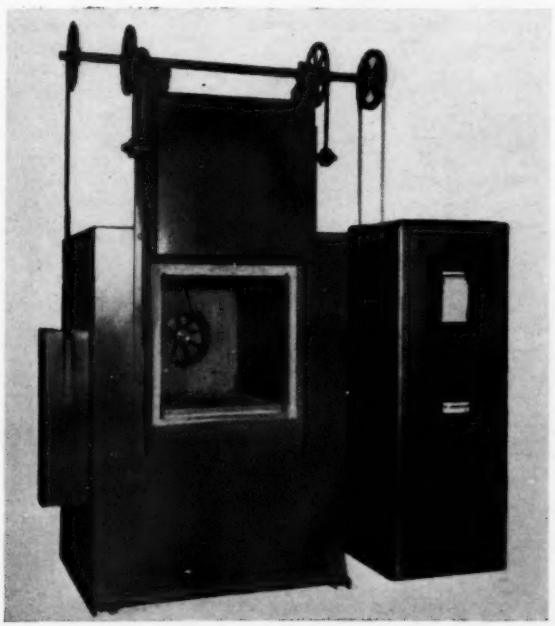
These saws are a product of G. Ott, Ulm-Donau, Germany, and are marketed in this country by The Addison Tool Co. Ltd., 10 Old Street, London, E.C.1.

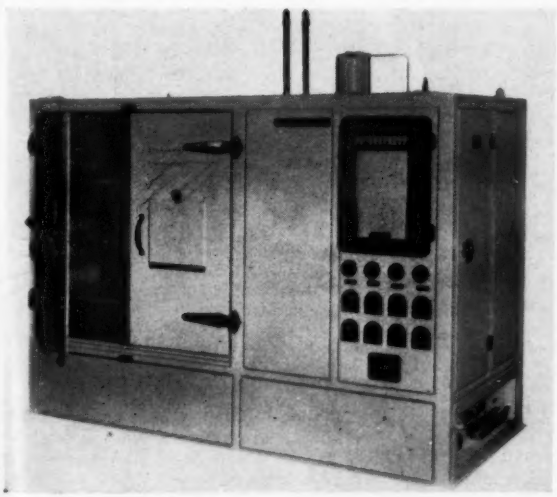
## Heat-Treatment

IN redesigning their electrical horizontal forced air circulating furnace, Hedin Ltd., Commerce Estate, South Woodford, London, E.18, have made improvements in its performance

*Right : The Hedin electrical horizontal forced air circulating furnace*

*Below : The Barlow-Whitney humidity test cabinet*





*The Hunter elevating hydraulic trolley for die-handling*

and simplified the construction. These furnaces are automatically controlled throughout and include the latest safety devices.

The centrifugal-type fan, which is of heat-resisting material, is designed to force large quantities of air under considerable pressure through the densest charge. Because the speed and volume of the airflow are both high, there is only a very small temperature variation throughout the heating chamber.

Should element replacement become necessary, the change can be made without disturbing the construction of the furnace. It is done merely by taking out the air guides (a few minutes' work) to reveal the elements. The refractories are designed to enable the elements to be removed and replaced quickly and easily. The highest grade heating elements are used, formed of heavy-section nickel chromium wire in helical coils.

All bearings are easily accessible for maintenance. The drive is via a standard V-belt and the fan shaft bearings are air-cooled. The door is counterbalanced and can be either hand or mechanically operated, as required.

## Die Handling

REMOVAL and replacement of a die in a press in a congested factory has always been a difficult problem to overcome, and to meet this problem an elevating hydraulic trolley has been especially designed by G. Hunter (London) Ltd., 80 Fenchurch Street, London, E.C.3. This truck has a roller top platform to prevent damage to the dies. The rollers can be locked so that the dies cannot fall off.

The truck has a loading height of 8 in. and lifts to the height required for fitting and also removal of the dies. The platform swivels through 360° and moves laterally a maximum of 6 in. to either side on a swinging arm. When manoeuvring in aisles, the die can be swung out into any position and then rotated. Effective lift is 27½ in., lowered height 9½ in., but extensions for higher lifts are available. Various capacities from ¼ ton to 1 ton are supplied.

Sturdily built on a low chassis, it has solid rubber tyres on double row ball bearings, two of which fully castor. The hydraulic system with a pivoting foot lever may be operated from either side of the truck. The self-locking release valve may be operated by a foot lever from either side of the truck and gives a controlled lowering speed.

## Pumping Fluids

FEATURES of a new portable electric barrel pump introduced by British Central Electrical Co. Ltd., 6 and 8 Rosebery Avenue, London, E.C.1, include:—the lifting, and inner tube containing driving shaft, for all lengths and types are easily removed and are interchangeable. Thus, the same pump can be used for water, oils, etc., and by replacing the lifting and inner tube assembly with one manufactured from austenitic stainless steel, it can be used for acids or other corrosive liquids, as required.

The lifting tube is easily inserted into normal barrel entries, as the overall external diameter is 1⅜ in. It is reinforced at the lower end to withstand rough use.

Self-priming, the pump will operate against full pressure, i.e. when in use with the quick action tap at the end of the hose closed, it will continue to function without overloading.

The pump is easily dismantled for cleaning and sterilizing the lifting parts, etc., which are in contact with the liquid.

Power transmission is through a 0·2 in. driving shaft via a positive coupling.

Should the pump be overloaded or overheated (beyond 60°F.) by the liquid being pumped, a thermal overcurrent cut-out in the motor housing disconnects the supply until the pump cools.

Among the many applications for which these portable barrel pumps are suitable are: extracting all liquids—paints, thinners, die-stuffs, fuel oil, lubricating oils, chemicals and/or acids—from drums, kegs, barrels, and carboys; emptying and filling hydraulic fluid storage tanks on presses, machine tools, etc.; for emptying or topping-up degreasing plants and plating vats with solvent or solution.

# Electrorefining of Nickel

A PROCESS employing direct electrolysis of nickel matte, has been developed by the International Nickel Company of Canada Limited.

The process eliminates high-temperature oxidation and reduction operations, with attendant losses of metals and sulphur and selenium. Instead, nickel sulphide of low copper content from the Bessemer converter or other source can be cast directly into sulphide anodes and electrolysed for the production of high quality nickel. Another unique feature of the process is that it permits, for the first time in nickel refining, the commercial recovery of elemental sulphur and selenium as valuable by-products, in addition to cobalt and precious metals conventionally recovered. At present, at Copper Cliff, Ontario, sulphur is being recovered in the form of liquid sulphur dioxide and sulphuric acid from the company's reduction works, and selenium is recovered in the refining of copper.

The process, for which Canadian and United States patents are pending, is in commercial operation in a section of the company's Port Colborne, Ontario, nickel refinery. Sulphur-selenium separation is accomplished in a 100 ft. high fractionating column of special design.

The interesting possibilities of the new method were first demonstrated in Inco laboratory tests in 1951, when a small piece of cast nickel sulphide was electrolysed. It corroded smoothly, the nickel and other base metals passing into solution, leaving a precious-metal bearing anode sludge containing 97 per cent elemental sulphur.

A number of obstacles to the recovery of sulphur of high purity from the sludge were resolved by laboratory and pilot plant investigations. These studies, conducted jointly with Blaw-Knox Company, resulted in the construction of a novel 100 tons/day sulphur fractional distillation unit. The sulphur from this unit contains less than five parts per million of selenium and has an unusually low ash and bitumens content. The selenium residue is shipped to Inco's copper refinery at Copper Cliff, Ontario, where it is processed for recovery of pure selenium.

# Industrial News *Home and Overseas*

### The B.M.S.

On Thursday of last week (March 27) some 150 members and guests attended the annual dinner of **The Birmingham Metallurgical Society,** which was held at the Imperial Hotel, Birmingham. The function was presided over by Mr. R. Chadwick, M.A., F.I.M., President of the Society, and the principal guests were the Lord Mayor of Birmingham's deputy, Alderman A. Lummis Gibson, and Dr. H. M. Finniston, B.Sc., A.R.T.C., F.I.M., of the Atomic Energy Research Establishment, Harwell.

Proposing the toast of "The City of Birmingham," the President drew attention to the long association of metal-working with the city, an association which began in the seventeenth century, before Birmingham had even a member of Parliament. In his response, Alderman A. Lummis Gibson also referred to local history.

The toast of "The Society" was proposed by Dr. Maurice Cook, F.I.M., chairman of the Metals Division, Imperial Chemical Industries Ltd., who referred to the influence on a national scale of this essentially local society. He also mentioned the help and encouragement it had always extended to the younger members. In his response to this toast, Mr. P. F. Hancock, B.A., F.I.M., dealt with some of the current programmes of the society and its aims for the future.

The toast of "The Guests" was proposed by Mr. H. H. Symonds, F.I.M., Immediate Past President of the Society, and the reply was made by Dr. H. M. Finniston.

During the course of the evening, the presentation of the Society Awards was made to the winners of the Essay Competition, whose names are given in the column headed "Men and Metals" on page 269 of this journal.

### Expansion at Tipton

Changing patterns of production, particularly in strip rolling, the demand for greater productivity and for higher quality strip, have led to a considerable development of the business of **Auxiliary Rolling Machinery Limited,** of Tipton. The main features of these changes are the rapid increase in the speeds at which machines operate, coupled with a tendency for many firms producing tube and sections to buy complete slitting lines, thus avoiding stocking many varieties of strip. A further development in their machinery has been brought about by general demand for larger coils.

To cope with this increased demand for high-speed equipment, A.R.M. have recently completed the first bay of their extension, on approximately 6,000 $yd^2$ of land adjoining the existing works. The new bay, 100 ft. by 50 ft., has a false end to permit further extension of 150 ft., and is primarily intended for the erection of large equipment such as tube mills (a 40 ft. mill for tubes up to $2\frac{1}{4}$ in. diameter has recently been completed), continuous cleaning machines, and heavy rolling mills.

At present this bay, which is designed for a 25-ton crane, houses some of the heavier plant which has been added to increase the firm's manufacturing facilities, including a $7\frac{1}{2}$ ton overhead crane, a large horizontal borer, and some large lathes. This heavy equipment is necessary in view of the firm's policy of manufacturing in their own works as much as possible of the machinery they produce. Only highly specialized equipment, motors and bearings are bought in.

A further development about to be undertaken is the erection of a further bay, 40 ft × 200 ft., alongside the first. When completed, this will become a machine shop, leaving the present shop clear for the erection of the rapidly extending range of products the company is being called on to make.

### Exhibition at Birmingham

At the exhibition of scientific apparatus held this week at the College of Technology, Birmingham, **Baird and Tatlock (London) Ltd.,** exhibited the B.T.L. "Analmatic" Karl Fischer Titrator, the B.T.L. rapid micro-combustion unit for the determination of carbon and hydrogen, the new B.T.L. wide range oven with fan, the B.T.L. electrolytic analysis apparatus, 3-test rotating electrode model, and a number of other B.T.L. specialities.

### Training for Young Welders

A new College of Further Education which has been recently opened at Darlington, at a cost of about £180,000, includes facilities which will enable students to learn the latest techniques in welding. A welding school has been built which can accommodate about 40 students. Courses are given in both oxy-acetylene welding and in arc welding.

Oxy-acetylene equipment supplied to the school by **British Oxygen Gases Limited** includes a 36 in. profile cutting machine, CH and DH type blowpipes, and Saffire hand welding and cutting blowpipes. There is a total of six oxy-acetylene welding booths. Arc welding equipment supplied by **Quasi-Arc Limited** includes an ACM 350/3 transformer welding set for use by three operators, and a TA 300 twin-arc welding set for use by one or two operators. In addition, Vertispeed, Vordian and Vortic electrodes have been supplied, mainly for positional welding, and Zodian and Radian electrodes will be used, mainly for welding in the flat position.

### Aluminium in Packaging

In the last issue of this journal (28 March, page 257), reference was made to a Symposium on "Aluminium in Packaging" which is being organized by the Aluminium Development Association, to be held on June 11 next. Notification has now been received from the Association to the effect that, due to unforeseen circumstances, this event will now take place on June 12 next at the Savoy Hotel, London.

### A London Exhibition

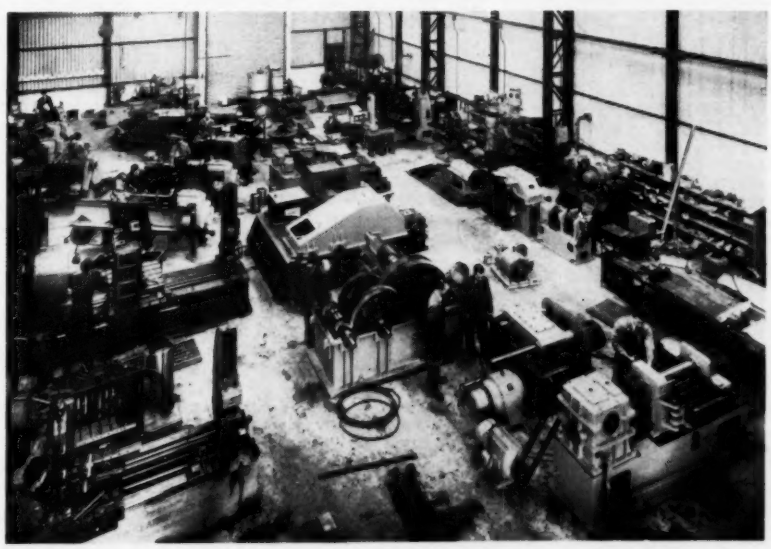
To be held at Grosvenor House and Park Lane House, London, W.1, from April 14 to 17, the Radio and Electronic Component Exhibition will contain a number of interesting products. Among the exhibitors are the following:—

**British Insulated Callender's Cables Ltd.,** who will be showing irradiated polythene equipment wires, radio frequency cables, audio frequency cables, and a range of winding wires.

**Minnesota Mining and Manufacturing Co. Ltd.,** who will display a complete range of their "Scotch Boy" electrical and magnetic recording tapes; the Metals Division of **Telegraph Construction and Maintenance Co. Ltd.** will show examples of the Telcon range of soft magnetic alloys, Mumetal, Radiometal, Rhometal, the standard range of Magnetic shields and thermostatic bimetals, together with beryllium copper.

**Westinghouse Brake and Signal Co. Ltd.** are to exhibit metal rectifiers suitable for radio and television H.T. supplies. Sealed contact-cooled rectifiers are also in production for export receivers where difficult climatic conditions have to be

*Interior view of new bay at Auxiliary Rolling Machinery Ltd., Tipton*



met, and miniature selenium and copper-oxide diodes and examples of rectifiers that have been specially developed to meet non-standard and specialized needs will also be shown.

### Branch Office Moves

It is learned from **British Insulated Callender's Cables Ltd.** that, as from Monday next, April 7, the address of their Dundee branch office will be 2 South Ward Road, Dundee, with the telephone number of 5926-7.

### Soviet Non-Ferrous Metals

At an electors' meeting held recently at Alma Ata, Kazakhstan, one of the inner circle of the Soviet leaders spoke on the mineral wealth of Kazakhstan. This part of the Soviet Union, he said, according to a *Pravda* report, had the largest chrome ore deposits in the world, and the largest copper, lead, zinc, cadmium and silver deposits of the Soviet Union. Deposits of manganese ore and molybdenum were also substantial.

### Gold Medal Award

On Wednesday, April 30 next, the **Society of Chemical Industry** will present its Castner Gold Medal to Dr. R. Holroyd, who will afterwards deliver the Castner Memorial Lecture, taking as his subject "The Development of the Petroleum Chemical Industry in Britain."

This event will take place at 6 p.m. in the Lecture Theatre, Department of Chemistry, King's College, Newcastle upon Tyne. Admission is open to all interested persons.

### Honours Presentation

At the Froghall Works of Thomas Bolton and Sons Limited, the Lord Lieutenant of Staffordshire (Mr. H. Wallace Copland) presented to **Mr. Bernard Theodore Walker** the British Empire Medal which he had been awarded by Her Majesty the Queen in her Honours List of New Year's Day, 1958.

Thomas Bolton and Sons Limited were formed in Birmingham in the year 1783, so that they are now celebrating the 175th anniversary of their foundation. The firm has been fortunate in the very many distinguished long-service records achieved by employees, as will be realized when it is stated that in respect of its four factories (Froghall and Oakamoor in Staffordshire and Widnes and St. Helens in Lancashire) there are, at the present time, 142 men still living who have completed at least 50 years of service with the firm, including, of course, those who are still working and those who have now retired from active service. The aggregate number of years of service represented by these old servants is 7,498. Equally notable is the number of people within the firm who have achieved 40 and 25 years of service.

It is a remarkable and happy coincidence, therefore, that in this celebration year there should have been this recognition by the Queen of the wonderful long-service records amongst the firm's employees, and particularly fitting that her choice should have fallen upon Mr. Walker who, prior to his retirement in September, 1957, achieved the magnificent record of 61 years and five months' service.

In the long history of the company it is the first time that an employee has been honoured by the Sovereign for his service to the firm. A further pointer to Mr. Walker's magnificent achievement of service is that, so far as is known from all the available records, it is believed that his is the second largest record of service in the firm's history. Mr. Walker celebrated his 76th birthday last month. Our photograph on this page shows the Lord Lieutenant making the presentation to Mr. Walker.

*Honours Presentation :—Mr. Walker receiving his award*

### Phosphates in Canada

Organic phosphates are shortly to be manufactured on a commercial scale in Canada for the first time, according to an announcement by Dr. David E. Jones, President of **Electric Reduction Company of Canada Ltd.**, one of the Albright and Wilson group of companies. Production is expected to start on May 1 next at Erco's Buckingham (Quebec) plant, recently considerably expanded. The present $500,000 annual Canadian market for organic phosphates has until now been supplied by exports from the United States and Europe.

### Locomotive Gearboxes

A contract worth nearly a quarter of a million pounds has been placed by North British Locomotive Co. Ltd. with the General Gear Division of **David Brown Industries Ltd.** for axle mounted gearboxes. This follows the placing of an order by British Railways for 52 main-line diesel/hydraulic locomotives. Fifty-six sets of the David Brown gearboxes have been ordered, each set comprising two primary and two secondary units.

### British Standards

Total number of British Standards issued between B.S.I.'s foundation in 1901 and the end of last year, exceeded 3,000. This fact emerges from the recently-published B.S.I. Yearbook for 1958, which includes a numerical list and brief descriptions of all standards current on December 31, 1957.

With this and a wealth of other information, the Yearbook is the only available "reference book" to British Standards, and, as such, it is of great value to every user of them. Apart from British Standards and Codes of Practice, the 520-page book also lists the publications issued by the International Organization for Standardization (ISO), the International Electrotechnical Commission (I.E.C.) and the International Commission on Rules for the Approval of Electrical Equipment (C.E.E.); these publications are all available for purchase from B.S.I.'s Sales Branch. Other sections of the book detail a number of B.S.I. services, from the list of industries for which "sectional lists" of current standards are published, to the "approval services" provided for United Kingdom manufacturers who export to Canada. There is also a comprehensive index in which all British Standards are listed according to their subjects.

### Metallurgical Analysis

Co-operation is the keynote of recent developments at the Birmingham firm of metallurgical assayers, **Ernest A. Lewis and Co. Ltd.**, who have recently moved to new premises at Prince Albert Street, Bordesley Green, Birmingham, 9. The move was made necessary by the increasing volume of business, creating a need for a larger laboratory and scope for further expansion.

Covering every aspect of analysis and investigation in metallurgy and such allied fields as refractories, fuels and waxes, this company handles work from places as distant as South Africa, U.S.A., and New Zealand, as well as a large volume of Midland business.

The new premises occupy some 500 $yd^2$, entirely on the ground floor, with adequate frontage and facilities for large lorry loads to be brought in for sampling. One of the shortcomings of the previous premises was that access was limited, and the advantages of being entirely on the ground floor for this class of work are already making themselves apparent. Office accommodation adjoins the frontage, and at the rear are a balance room, dark room, chemical laboratory, and preparation room. A separate building provides accommodation for the ball mill and similar equipment.

In the main laboratory, equipment for all types of wet analysis is provided, with a special electrochemical section. Because of the very wide range of samples dealt with, and hence the variety of analyses that have to be made, fundamental techniques are widely used. In addition to the normal photographic equipment, the dark room also houses a metallurgical microscope and a Spekker absorptiometer. Much of the equipment has been designed and built by the laboratory staff, and they have also taken part in planning the new building, the disposition and height of work benches, lighting, and arrangement of equipment all having been settled as a result of joint discussions.

*A corner of the new laboratory of Ernest A. Lewis Ltd.*

The fume cupboard at one end of the laboratory, has been built outside the laboratory proper, on what was previously a loading deck. This unusually spacious cupboard 16 ft × 5 ft × 5 ft. high, provides ample room for hotplates, etc. Fumes from this cupboard are extracted by a motor-driven fan via heat-resisting glass ducting, the extraction system being housed outside the laboratory.

Adjoining the fume cupboard is a preparation shop with facilities for drilling, grinding and melting of samples, and the preparing, mounting and polishing of micro specimens.

### Sciaky Welding

A selection of resistance welding machines will be exhibited by **Sciaky Electric Welding Machines Ltd.** in conjunction with the Merseyside and North Wales Electricity Board at their Industrial Development Centre, Cleveland Square, Paradise Street, Liverpool, from May 12 to 23 next. On Thursday, May 15, at 6.30 p.m., an illustrated lecture on resistance welding will be given at the Centre.

### A New Edition

Just published is the 1958 edition of **Metal Industry Handbook and Directory**, which has become a standard work of reference offering a comprehensive source of information to all those engaged in, or connected with, the non-ferrous metal industries. Information on the properties of the newer, as well as more familiar, metals has been brought up to date, and the extensive section devoted to summaries of British Standard Aircraft Material, D.T.D., and Admiralty specifications has again been included.

A very wide range of producers, stockists and factors of all basic metal products, metal-working machinery and tools, and metal finishing equipment is listed in the Directory for Buyers. The handbook also includes a section on the chief metal finishing processes and data regarding all the common rod, bar, sheet, and strip products.

All who manufacture, use or deal in non-ferrous metals will require this useful book, which is now in its 47th year of publication. A complimentary copy is issued to all subscribers to METAL INDUSTRY, but it may be obtained at the price of 15s. net (by post 16s. 6d.).

### New Address

We are informed by **The Addison Tool Company Ltd.** that they have now moved into larger premises with modern office, showroom and warehouse facilities, at Addison House, 28 Marshalsea Road, London, S.E.1. The new telephone number is Hop 0577-8.

### Electricity and Copper

Typical of the vast amount of copper used in any large electrical undertaking are the 9½ tons of this metal employed in the manufacture of each of the eight Parsons turbo electric generators which will be installed in the Calder Hall atomic power station.

### London Representative

It has been announced by the **Suffolk Iron Foundry (1920) Ltd.** that Mr. W. E. A. Williams has been appointed Sifbronze technical representative for London and South-East England. Before taking up this appointment, Mr. Williams was manager of the welding department at F. J. Edwards Ltd. He will operate from 100 Preston Lane, Tadworth, Surrey.

### New Calendar

Just distributed is the annual calendar (from April, 1958, to March, 1959) produced by **The Eyre Smelting Company Ltd.** Each sheet of the calendar contains a photograph of a British sports event, and special sheets are included giving details of sporting achievements and a diary of the leading sporting events for the coming 12 months.

### Rhodesian Output

According to the latest figures released by the Department of Mines in Kitwe, the total value of Northern Rhodesian mineral output in January, 1958, rose to £7,435,606, from £6,933,068 in December, 1957, but showed a decline from the January, 1957, figure of £9,578,188. Production of electrolytic copper during the month increased to 24,697 tons, valued at £4,230,836, from the 20,293 tons, valued at £3,681,185, in the previous month. Copper concentrate output also rose—to 286 tons from 236 tons, valued at £10,012 and £8,230 respectively. Blister copper production, however, declined to 15,574 tons, from 16,518 tons in December. The respective values were £2,423,606 and £2,736,129.

Lead output during the month under review totalled 1,100 tons, with a value of £79,385, against 1,400 tons, valued at £102,498, in the preceding month. There was a slight decline in the value of zinc produced—to £157,984 from £158,555—despite an unchanged output of 2,525 tons. Production of manganese ore in January rose to 2,744 tons, worth £32,831, from 2,492 tons, worth £31,116, in December.

### Chinese Tin for Japan

Reports from Tokyo state that Toho Bussan Kaisha, a Japanese trade firm specializing in trade with Communist countries, has announced that it has concluded a contract for the importation of 70 tons of tin from China at a very low price in barter with Japanese steel products. The contract price was £706 sterling per ton, f.o.b., for standard quality of tin content 99·9 per cent, the company said. The quality of the tin to be imported will be a combination of tin content 99·9 per cent, 99·56 per cent and 99 per cent.

This will be the first Japanese import of tin from China since the war. The Japan Mining Industry said Japan was heavily dependent on imports for her annual tin requirements of 10,000 tons, as her domestic production totalled only about 1,000 tons annually. Most of the imports came from Malaya.

### A New Product

We are informed by **Electrical Remote Control Co. Ltd.** that they have now in production soldering iron type LV20/PO. The performance of this soldering iron is said to be outstanding, as the whole of the element is inserted inside the soldering bit.

The soldering iron is provided with a heat shield. This heat shield covers the hot stem of the soldering iron, eliminating thereby accidental damage which is frequently caused by the P.V.C. covering of wires touching the hot stem when soldering between closely spaced connections. The soldering iron can also be supplied with an external metal cover, with bayonet type of lock which is extremely useful when the soldering iron is used for maintenance work (plugged into car battery or any other low voltage source) and has to be put in the tool kit quickly without waiting for cooling off. This new unit is priced at 21s.

## Forthcoming Meetings

**April 10—Institute of Metals.** London Local Section. 17 Belgrave Square, London, S.W.1. Annual General Meeting, followed by "New Protective Coatings for Metals." W. E. Ballard. 6.30 p.m.

**April 10 — Leeds Metallurgical Society.** West Yorkshire Foundries Limited, Leeds. "Pressure Die-Casting." G. Kelly. 7.15 p.m.

**April 10 — Institute of British Foundrymen.** Beds. and Herts. Section. Annual General Meeting. K. and L. Steelfounders and Engineers Limited, Letchworth. 7.30 p.m.

# Metal Market News

WALL STREET sessions were rather erratic last week, but it must be admitted that, on the whole, prices on that market keep up surprisingly well, many investors probably believing that the President will be compelled sooner or later to put in hand schemes calculated to reduce unemployment and quicken the pulse of trade. Some apprehension is probably felt about the March figures of unemployment when they become available and, moreover, there is the question of the trading results of various companies for that period. So far as this country is concerned, while it is appreciated that business is still good and industrial activity relatively on a better footing than in the United States, there is also the knowledge that we are over-all below the level of activity obtaining six months ago, and probably still losing ground in certain directions. On the whole, however, the U.K. and Western Europe are doing pretty well. On the non-ferrous front, the big item of news last week was the slashing of the aluminium price by 2 cents per lb. in the States and the reduction of £17 to £180 in the U.K. Consumption of this metal has fallen, but production has been maintained, or even increased, so that the statistical position is not very happy. Aluminium of Russian origin has been selling cheaply in the U.K. and this competition must be deemed to have had something to do with the drastic cut in the quotation. It now remains to be seen what action the Russians will take in order to maintain their position in this market. Coupled with the reduction in steel prices and the easier trend of three out of four of the non-ferrous metals in Whittington Avenue, it does not seem to be wrong to read into the present situation a generally downward trend in commodity prices.

That the fall in the aluminium quotation comes as something of a body blow to copper can hardly be doubted, since a price reduction of this magnitude gives the light metal a useful boost in the struggle for preference in those fields where copper and aluminium are in competition. That field is not a small one, and the gains made at copper's expense over the years have been considerable. The news of the reduction in the aluminium quotation was certainly not without its effect on the trend of copper prices in Whittington Avenue, but it was offset by a worsening of the strike news from Chile, where workers at the Chuquicamata property are threatening to cease operations. Moreover, the Belgian quotation was advanced for the second time in the week to 25 francs per kilo. Given a settlement of the Chilean dispute, however, it seems very likely that the impact of the aluminium price reduction will be more noticeable. The U.K. consumption figures for February, which are not expected to be very favourable, will be available next month, and the Easter holiday will also have its effect on consumption. In the meanwhile, the speculative boom in copper futures in New York continues at a lower rate, but it is still influencing sentiment in London.

Copper stocks last week were reported 411 tons down at 19,411 tons, while the turnover in trading on the standard market added up to 10,500 tons, prices finishing level at £177 5s. 0d., a gain of 30s. for cash and 20s. three months. Earlier in the week, the custom smelters' quotation had gone up to 24 cents, but at that level demand rather petered out. The producers' price was unchanged at 25 cents. On a turnover of 1,195 tons, tin was unchanged for cash but £5 down for three months, and at the close of trading on Friday afternoon there was a backwardation of 10s. This market now seems to be under some pressure. Lead was weak on a turnover of 4,060 tons, finishing £2 2s. 6d. down for March at £73 17s. 6d., and 30s. lower for June at £74. Zinc also lost ground on a turnover of 4,300 tons, for both positions closed 15s. down at £63 10s. 0d. L.M.E. warehouse stocks of tin at 17,927 tons were 118 tons higher.

**New York**

The copper market actively improved last week-end, but the quickened tempo was restricted to custom smelter copper and to copper futures. Custom smelters did an active business and were enabled to raise their price 1 cent to 24 cents a lb., with activity latterly continuing at a good pace at the 24 cent level. Producers, however, reported slow sales at 25 cents and copper analysts wondered whether the custom smelter betterment represented the beginning of a sustained upturn in the copper market, or a temporary improvement.

Some trade sources said the active custom smelter buying could reflect the hectic trading in the copper futures and a move by fabricators to fill immediate needs at what they considered a bottom price. However, analysts noted that key users of copper were not showing an improvement in end-usage of copper. This caused some keen observers to counsel caution regarding optimism about an impending improvement. These sources said the next few weeks should be decisive. Meanwhile, they pointed out that production was still in excess of demand, and further output cutbacks might be necessary in order to put demand and supply in balance.

Copper futures trading on the New York Commodity Exchange reached post-war turnover peaks with the price firm, although some profit-taking latterly developed. However, informed trade sources noted that activity was highly speculative and included traders having no ties with the copper industry. These sources said a "deluge" of selling could hit the futures market in the near future if profit-taking expanded, and this could have some unfavourable effects on the physical copper market.

Lead and zinc continued quiet, with the trade interest centred in the Washington hearings of the Senate Interior Committee. The Government may submit a long range minerals plan by April 15, the Secretary of the Interior has indicated to the Committee.

Tin was mixed latterly; prices tended modestly lower, reflecting lack of interest by consumers.

**Birmingham**

Business in the metal-using industries in the Midlands is maintained on a good scale. Works will be closing this week-end for the first holiday of the year, but there will be a good carry-over of orders. The motor trade keeps up well and component-making firms look forward with confidence to a steady spell of work during the next few months. There is less work in the building trade and this is undoubtedly due in part to the severe cuts in public spending and the tightness of money generally. In the machine tool industry manufacturers have reduced their order books and some short time is being worked.

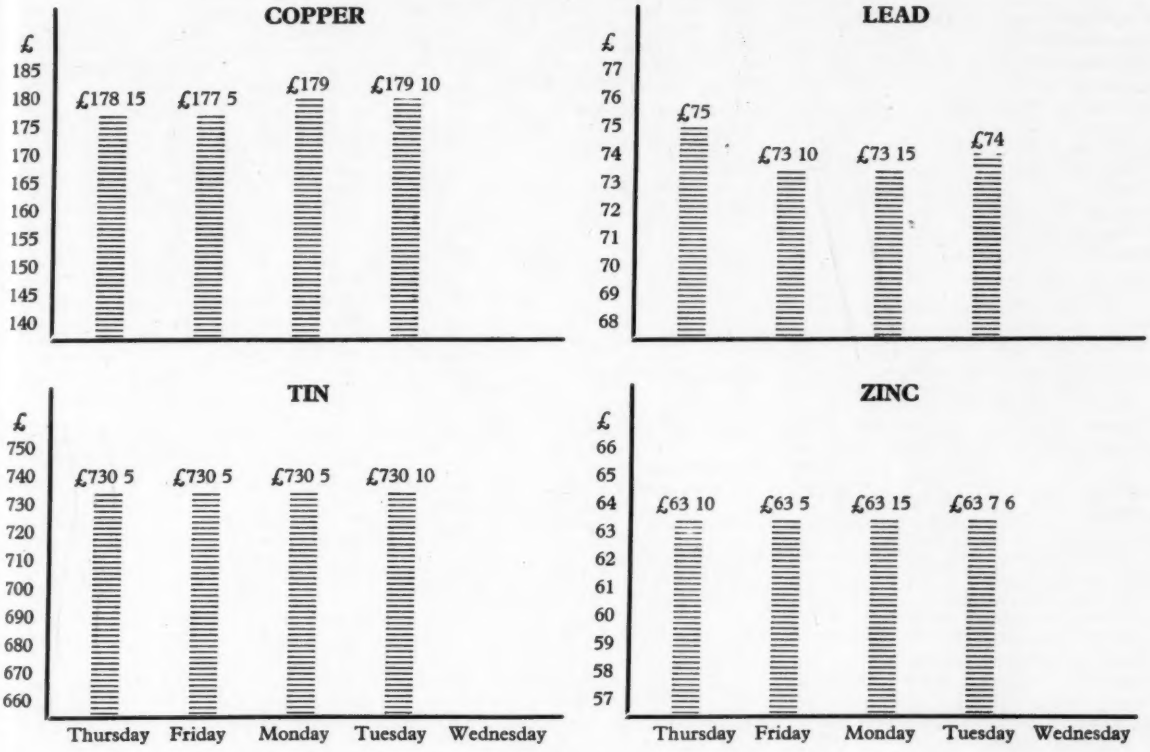
Amongst iron and steel users, stocks are heavier than they have been for a long time. This is particularly noticeable as far as pig iron is concerned. There is no surplus of plates and sheets. On the contrary, steel mills have not yet reached the stage when they can meet the whole of the demand. Activity in the motor trade keeps up the pressure for steel sheets. Re-rollers are unable to work to capacity owing to a shortage of orders, and stocks of semi-finished steel are heavy. Makers of heavy castings for the engineering trades are fully occupied and the outlook is favourable. Imports of nearly all steel products continue to decline.

**Indonesia**

It is believed that discussions are going on regarding the question of the treatment of Indonesian tin in ore at a European smelter other than Arnhem. Final decision on this point is possible in the near future, trade quarters say. All the Indonesian ores, other than that part of the Banka production which is going to the Texas City smelter, will presumably be treated at this smelter.

# METAL PRICE CHANGES

LONDON METAL EXCHANGE, Thursday 27 March 1958 to Tuesday 1 April 1958




# OVERSEAS PRICES

Latest avaliable quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

| | Belgium fr/kg ≏ £/ton | Canada c/lb ≏ £/ton | France fr/kg ≏ £/ton | Italy lire/kg ≏ £/ton | Switzerland fr/kg ≏ £/ton | United States c/lb ≏ £/ton |
|---|---|---|---|---|---|---|
| **Aluminium** | | 24.63 203 10 | 210 182 15 | 400 232 0 | 2.50 209 0 | 28.10 224 17 6 |
| **Antimony** 99.0 | | | 195 169 12 6 | 430 249 10 | | 29.00 232 0 |
| **Cadmium** | | | 1,400 1,218 0 | 2,550 1,479 0 | | 155.00 1,240 0 |
| **Copper** | | | | | | |
| Crude | | | | | | |
| Wire bars 99.9 | | | | 365 211 15 | | |
| Electrolytic | 24.25 177 5 | 24.50 202 7 6 | 224 194 17 6 | | 2.10 175 12 6 | 25.00 200 0 |
| **Lead** | | 12.25 101 2 6 | 123 107 0 | 184 106 15 0 | .95 79 10 | 13.00 104 0 |
| **Magnesium** | | | | | | |
| **Nickel** | | 71.50 590 10 | 1,205 104 17 6 | 1,330 771 10 | 7.80 652 5 | 74.00 592 0 |
| **Tin** | 102.50 749 5 | | 898 781 5 | 1,420 823 12 6 | 8.70 727 10 | 93.25 746 0 |
| **Zinc** | | | | | | |
| Prime western | | 10.00 82 12 6 | | | | 10.00 80 0 |
| High grade 99.95 | | 10.60 87 10 0 | | | | |
| High grade 99.99 | | 11.00 90 5 | | | | |
| Thermic | | | 107.12 93 2 6 | | | |
| Electrolytic | | | 115.12 100 2 6 | 159 92 5 | .82 68 10 | 11.75 94 0 |

# NON-FERROUS METAL PRICES

(All prices quoted are those available at 12 noon 1/4/58)

## PRIMARY METALS

| | | £ | s. | d. |
|---|---|---|---|---|
| **Aluminium** Ingots | ton | 180 | 0 | 0 |
| **Antimony** 99·6% | „ | 197 | 0 | 0 |
| **Antimony** Metal 99% | „ | 190 | 0 | 0 |
| **Antimony** Oxide | „ | 180 | 0 | 0 |
| **Antimony** Sulphide Lump | „ | 190 | 0 | 0 |
| **Antimony** Sulphide Black Powder | „ | 205 | 0 | 0 |
| **Arsenic** | „ | 400 | 0 | 0 |
| **Bismuth** 99·95% | lb. | | 16 | 0 |
| **Cadmium** 99·9% | „ | | 10 | 0 |
| **Calcium** | „ | 2 | 0 | 0 |
| **Cerium** 99% | „ | 13 | 18 | 0 |
| **Chromium** | „ | | 6 | 11 |
| **Cobalt** | „ | | 16 | 0 |
| **Columbite** | per unit | | — | |
| **Copper** H.C. Electro | ton | 179 | 10 | 0 |
| Fire Refined 99·70% | „ | 178 | 0 | 0 |
| Fire Refined 99·50% | „ | 177 | 0 | 0 |
| **Copper Sulphate** | „ | 66 | 0 | 0 |
| **Germanium** | grm. | | — | |
| **Gold** | oz. | 12 | 9 | 3½ |
| **Indium** | „ | | 10 | 0 |
| **Iridium** | „ | 26 | 0 | 0 |
| **Lanthanum** | grm. | | 15 | 0 |
| **Lead** English | ton | 74 | 0 | 0 |
| **Magnesium** Ingots | lb. | | 2 | 5½ |
| Notched Bar | „ | | 2 | 10½ |
| Powder Grade 4 | „ | | 6 | 3 |
| Alloy Ingot, A8 or AZ91 | „ | | 2 | 8 |
| **Manganese Metal** | ton | 300 | 0 | 0 |
| **Mercury** | flask | 77 | 0 | 0 |
| **Molybdenum** | lb. | 1 | 10 | 0 |
| **Nickel** | ton | 600 | 0 | 0 |
| F. Shot | lb. | | 5 | 5 |
| F. Ingot | „ | | 5 | 6 |
| **Osmium** | oz. | | nom. | |
| **Osmiridium** | „ | | nom. | |
| **Palladium** | „ | 7 | 10 | 0 |
| **Platinum** | „ | 26 | 15 | 0 |
| **Rhodium** | „ | 40 | 0 | 0 |
| **Ruthenium** | „ | 16 | 0 | 0 |
| **Selenium** | lb. | | nom. | |
| **Silicon** 98% | ton | | nom. | |
| **Silver** Spot Bars | oz. | | 6 | 4 |
| **Tellurium** | lb. | | 15 | 0 |
| **Tin** | ton | 730 | 10 | 0 |
| ***Zinc** | | | | |
| Electrolytic | ton | | — | |
| Min 99·99% | „ | | — | |
| Virgin Min 98% | „ | 63 | 4 | 4½ |
| Dust 95/97% | „ | 104 | 0 | 0 |
| Dust 98/99% | „ | 110 | 0 | 0 |
| Granulated 99+% | „ | 88 | 4 | 4½ |
| Granulated 99·99+% | „ | 101 | 6 | 3 |

**Duty and Carriage to customers' works for buyers' account.*

## INGOT METALS

| **Aluminium Alloy (Virgin)** | | £ | s. | d. |
|---|---|---|---|---|
| B.S. 1490 L.M.5 | ton | | — | |
| B.S. 1490 L.M.6 | „ | | — | |
| B.S. 1490 L.M.7 | „ | | — | |
| B.S. 1490 L.M.8 | „ | | — | |
| B.S. 1490 L.M.9 | „ | | — | |
| B.S. 1490 L.M.10 | „ | | — | |
| B.S. 1490 L.M.11 | „ | | — | |
| B.S. 1490 L.M.12 | „ | | — | |
| B.S. 1490 L.M.13 | „ | | — | |
| B.S. 1490 L.M.14 | „ | | — | |
| B.S. 1490 L.M.15 | „ | | — | |
| B.S. 1490 L.M.16 | „ | | — | |
| B.S. 1490 L.M.18 | „ | | — | |
| B.S. 1490 L.M.22 | „ | | — | |

| | | £ | s. | d. |
|---|---|---|---|---|
| **†Aluminium Alloy (Secondary)** | | | | |
| B.S. 1490 L.M.1 | ton | 155 | 0 | 0 |
| B.S. 1490 L.M.2 | „ | 161 | 10 | 0 |
| B.S. 1490 L.M.4 | „ | 182 | 10 | 0 |
| B.S. 1490 L.M.6 | „ | 204 | 10 | 0 |
| †Average selling prices for February | | | | |
| ***Aluminium Bronze** | | | | |
| BSS 1400 AB.1 | ton | 200 | 0 | 0 |
| BSS 1400 AB.2 | „ | | — | |
| ***Brass** | | | | |
| BSS 1400-B3 65/35 | „ | 130 | 0 | 0 |
| BSS 249 | „ | | — | |
| BSS 1400-B6 85/15 | „ | | — | |
| ***Gunmetal** | | | | |
| R.C.H. 3/4% | ton | | — | |
| (85/5/5/5) | „ | 155 | 0 | 0 |
| (86/7/5/2) | „ | 167 | 0 | 0 |
| (88/10/2/1) | „ | 217 | 0 | 0 |
| (88/10/2/½) | „ | 224 | 0 | 0 |
| **Manganese Bronze** | | | | |
| BSS 1400 HTB1 | „ | 167 | 0 | 0 |
| BSS 1400 HTB2 | „ | 182 | 0 | 0 |
| BSS 1400 HTB3 | „ | 189 | 0 | 0 |
| **Nickel Silver** | | | | |
| Casting Quality 12% | „ | | nom. | |
| „ „ 16% | „ | | nom. | |
| „ „ 18% | „ | | nom. | |
| ***Phosphor Bronze** | | | | |
| 2B8 guaranteed A.I.D. released | „ | 240 | 0 | 0 |
| **Phosphor Copper** | | | | |
| 10% | „ | 208 | 0 | 0 |
| 15% | „ | 216 | 0 | 0 |
| **Average prices for the last week-end.* | | | | |
| **Phosphor Tin** | | | | |
| 5% | ton | | — | |
| **Silicon Bronze** | | | | |
| BSS 1400-SB1 | „ | | — | |
| **Solder**, soft, BSS 219 | | | | |
| Grade C Tinmans | „ | 345 | 9 | 0 |
| Grade D Plumbers | „ | 280 | 3 | 0 |
| Grade M | „ | 378 | 9 | 0 |
| **Solder,** Brazing, BSS 1845 | | | | |
| Type 8 (Granulated) | lb. | | — | |
| Type 9 „ | „ | | — | |
| **Zinc Alloys** | | | | |
| Mazak III | ton | 94 | 11 | 3 |
| Mazak V | „ | 98 | 11 | 3 |
| Kayem | „ | 104 | 11 | 3 |
| Kayem II | „ | 110 | 11 | 3 |
| Sodium-Zinc | lb. | | 2 | 5 |

## SEMI-FABRICATED PRODUCTS

Prices of all semi-fabricated products vary according to dimensions and quantities. The following are the basis prices for certain specific products.

| **Aluminium** | | £ | s. | d. |
|---|---|---|---|---|
| Sheet 10 S.W.G. | lb. | | 2 | 9 |
| Sheet 18 S.W.G. | „ | | 2 | 11 |
| Sheet 24 S.W.G. | „ | | 3 | 2 |
| Strip 10 S.W.G. | „ | | 2 | 9 |
| Strip 18 S.W.G. | „ | | 2 | 10 |
| Strip 24 S.W.G. | „ | | 2 | 11½ |
| Circles 22 S.W.G. | „ | | 3 | 3 |
| Circles 18 S.W.G. | „ | | 3 | 2 |
| Circles 12 S.W.G. | „ | | 3 | 1 |
| Plate as rolled | „ | | 2 | 8½ |
| Sections | „ | | 3 | 2½ |
| Wire 10 S.W.G. | „ | | 3 | 0 |
| Tubes 1 in. o.d. 16 S.W.G. | „ | | 4 | 1 |
| **Aluminium Alloys** | | | | |
| BS1470. HS10W. | lb. | | | |
| Sheet 10 S.W.G. | „ | | 3 | 1½ |
| Sheet 18 S.W.G. | „ | | 3 | 4 |
| Sheet 24 S.W.G. | „ | | 3 | 11½ |
| Strip 10 S.W.G. | „ | | 3 | 1½ |
| Strip 18 S.W.G. | „ | | 3 | 3 |
| Strip 24 S.W.G. | „ | | 3 | 11 |
| BS1477 HP30M. Plate as rolled | | | 2 | 11½ |
| BS1470. HC15WP. | | | | |
| Sheet 10 S.W.G. | lb. | | 3 | 9½ |
| Sheet 18 S.W.G. | „ | | 4 | 1½ |
| Sheet 24 S.W.G. | „ | | 4 | 11½ |
| Strip 10 S.W.G. | „ | | 3 | 10½ |
| Strip 18 S.W.G. | „ | | 4 | 1½ |
| Strip 24 S.W.G. | „ | | 4 | 9 |
| BS1477. HPC15WP. Plate heat treated | „ | | 3 | 6½ |
| BS1475. HG10W. Wire 10 S.W.G. | „ | | 3 | 10½ |
| BS1471. HT10WP Tubes 1 in. o.d. 16 S.W.G. | „ | | 5 | 0 |
| BS1476. HE10WP. Sections | „ | | 3 | 2 |
| **Beryllium Copper** | | | | |
| Strip | „ | 1 | 4 | 11 |
| Rod | „ | 1 | 1 | 6 |
| Wire | „ | 1 | 4 | 9 |
| **Brass** Tubes | „ | | 1 | 5½ |
| Brazed Tubes | „ | | — | |
| Drawn Strip Sections | „ | | — | |
| Sheet | ton | | — | |
| Strip | „ | 207 | 0 | 0 |
| Extruded Bar | lb. | | 1 | 8⅜ |
| Extruded Bar (Pure Metal Basis) | „ | | — | |
| Condenser Plate (Yellow Metal) | ton | 148 | 0 | 0 |
| Condenser Plate (Naval Brass) | „ | 158 | 0 | 0 |
| Wire | lb. | | 2 | 3½ |
| **Copper** Tubes | lb. | | 1 | 9 |
| Sheet | ton | 200 | 5 | 0 |
| Strip | „ | 200 | 5 | 0 |
| Plain Plates | „ | | — | |
| Locomotive Rods | „ | | — | |
| H.C. Wire | „ | 226 | 5 | 0 |
| **Cupro Nickel** Tubes 70/30 | lb. | | 3 | 2 |
| **Lead** Pipes (London) | ton | 115 | 5 | 0 |
| Sheets (London) | „ | 113 | 0 | 0 |
| Tellurium Lead | „ | £6 extra | | |
| **Nickel Silver** | | | | |
| Sheet and Strip 7% | „ | | 3 | 2½ |
| Wire 10% | „ | | 3 | 9 |
| **Phosphor Bronze** Wire | „ | | 3 | 6½ |
| **Titanium** (10,000 lb. lots) | | | | |
| Billet 11″-4″ | lb. | 69/- | 60/- | |
| Wire ·315″-·036″ | „ | 101/- | 201/- | |
| Sheet (4′/8′×2′) ·160″-·010″ | „ | 100/- | 158/- | |
| Strip ·048″-·003″ | „ | 100/- | 350/- | |
| Tube Representative gauge | „ | 320/- | | |
| Extrusions | „ | 137/- | | |
| **Zinc** Sheets, English destinations | ton | 98 | 0 | 0 |
| Strip | „ | nom. | | |

# Scrap Metal Prices

Merchants' average buying prices delivered, per ton, 31/3/58.

| | £ |
|---|---|
| **Aluminium** | |
| New Cuttings | 150 |
| Old Rolled | 120 |
| Segregated Turnings | 90 |
| **Brass** | |
| Cuttings | 112 |
| Rod Ends | 109 |
| Heavy Yellow | 95 |
| Light | 90 |
| Rolled | 104 |
| Collected Scrap | 94 |
| Turnings | 104 |
| **Copper** | |
| Wire | 153 |
| Firebox, cut up | 153 |
| Heavy | 148 |
| Light | 143 |
| Cuttings | 153 |
| Turnings | 140 |
| Braziery | 120 |
| **Gunmetal** | |
| Gear Wheels | 150 |
| Admiralty | 150 |
| Commercial | 126 |
| Turnings | 121 |
| **Lead** | |
| Scrap | 65/10 |
| **Nickel** | |
| Cuttings | — |
| Anodes | 525 |
| **Phosphor Bronze** | |
| Scrap | 126 |
| Turnings | 121 |
| **Zinc** | |
| Remelted | — |
| Cuttings | 40 |
| Old Zinc | 28 |

The latest available scrap prices quoted on foreign markets are as follow. (The figures in brackets give the English equivalents in £1 per ton):—

| | | |
|---|---|---|
| **West Germany** (D-marks per 100 kilos): | | |
| Used copper wire | (£156.12.6) | 180 |
| Heavy copper | (£152.5.0) | 175 |
| Light copper | (£130.10.0) | 150 |
| Heavy brass | (£100.0.0) | 115 |
| Light brass | (£69.12.6) | 80 |
| Soft lead scrap | (£61.0.0) | 70 |
| Zinc scrap | (£39.2.6) | 45 |
| Used aluminium unsorted | (£87.0.0) | 100 |
| **France** (francs per kilo): | | |
| Copper | (£204.10.0) | 235 |
| Heavy copper | (£204.10.0) | 235 |
| Light brass | (£148.0.0) | 170 |
| Zinc castings | (£67.0.0) | 77 |
| Tin | (£565.10.0) | 650 |
| Aluminium pans (98½ per cent) | (£130.10.0) | 150 |
| **Italy** (lire per kilo): | | |
| Aluminium soft sheet clippings (new) | (£194.7.6) | 335 |
| Aluminium copper alloy | (£104.10.0) | 180 |
| Lead, soft, first quality | (£87.0.0) | 150 |
| Lead, battery plates | (£52.5.0) | 90 |
| Copper, first grade | (£168.5.0) | 290 |
| Copper, second grade | (£156.12.6) | 270 |
| Bronze, first quality machinery | (£171.2.6) | 295 |
| Bronze, commercial gunmetal | (£142.2.6) | 245 |
| Brass, heavy | (£119.0.0) | 205 |
| Brass, light | (£107.7.6) | 185 |
| Brass, bar turnings | (£121.17.6) | 210 |
| New zinc sheet clippings | (£55.2.6) | 95 |
| Old zinc | (£40.12.6) | 70 |

# Financial News

### Aluminium Price Cut

Aluminium Union Limited, distributors of the Aluminum Company of Canada Limited in the United Kingdom, announce that their U.K. price of virgin aluminium ingot of 99·5 per cent minimum purity is reduced from £197 to £180 per long ton, delivered consumers' works. It is understood that Aluminum Company of Canada will still grant a "loyalty discount" of two per cent to those consumers who agree to take no other aluminium than Canadian.

On the new price of £180 this represents a discount of about £3 12s. 0d. It was recently believed that Russian metal was available at down to about £177 per ton, c.i.f. for a reasonable quantity of 100 tons or more. It now remains to be seen whether Russia will lower her price to become more competitive with Canada. Now that Canadian metal has been reduced, some quarters suggest that should Russian prices go down sharply, it could enhance the prospects of an anti-dumping duty being imposed on Russian metal, application for which was made some time ago by Aluminum Company of Canada. In 1957, the United Kingdom imported about 15,500 tons of Russian aluminium against a mere 197 tons in 1956. In January, 1958, imports were 1,746 tons.

### Anti-Attrition Metal Co.

Dividend 4 per cent for year ended July 31, 1957. Profit £28,930 (£82,108), before tax of £11,875 (£39,250). To superannuation trustees £2,000 (same), loss on realization of assets £536 (£952), plant replacement reserve £9,000 (same), forward £33,910 (£37,591). A larger amount has been retained by subsidiaries.

### Aluminium Corporation

Net profit 1957 £82,904 (£88,522) and dividend 17½ per cent (same). Fixed assets £254,295 (£255,403) and assets being constructed £46,793 (nil). Net current assets £425.718 (£426,986). Future tax £86,000 (£91.500). Commitments £366,000 (£133,500).

### James Booth and Co. Ltd.

Final dividend 4 per cent, making 9 per cent for 1957 (12 per cent). Group net profit £141.417 (£157,683) after tax of £158,101 (£202,023), etc. To general reserves £156,358 (£25,000), re-equipment and development reserves nil (£52,557).

### British Aluminium Co. Ltd.

Final dividend for 1957 is 8 per cent on the capital increased from £7m. to £9m. by a "rights" issue; an interim of 4 per cent was paid on the smaller capital. Group trading profits fell by £371,870 to £4,030,871. After deducting tax of £1,617,345 (£1,852,251), and crediting tax provision no longer required of £651,720 (£253,280), net profits emerged £314,840 higher at £1,899,109.

### Charles Clifford Ltd.

Group net profit 1957 £51,121 (£65,291) and dividend 10 per cent (same). Fixed assets £374,959 (£288,671), current assets £1,017,506 (£1,180,679) and liabilities £176,694 (£280,934). Reserves £550,121 (£512,279) and future tax £65,650 (£76,137). Commitments £31,700 (£86,000).

### Imperial Chemical Industries Ltd.

The profit and loss account for I.C.I. and its home and overseas subsidiaries for the year ended December 31, 1957, shows that group sales to external customers totalled £463 millions, compared with £435 millions in 1956. Group income was £55,135,296 (£50,121,439) before taxation and £28,807,218 (£26,356,605) afterwards. Income after taxation was £22,141,474 (£19,293,139). The directors recommend a final dividend on the company's Ordinary stock of 8 per cent, less tax, making—with the interim of 4 per cent—a total of 12 per cent for the year 1957 (10 per cent for 1956)

### Minnesota Mining

Annual accounts of Minnesota Mining and Manufacturing Company show net profit for 1957 at £401,392 (£218,162). To interim dividend £132,480 (same), surplus at end of year £1,101,275 (£832,363). Fixed assets £1,272,134 (£1,120,380), current assets £2,474,912 (£2,150,676) and liabilities £816,714 (£764,925).

# New Companies

The particulars of companies recently registered are quoted from the daily register compiled by Jordan and Sons Limited, Company Registration Agents, Chancery Lane, W.C.2.

**May (Metals) and Co. Ltd.** (598540), 29 St. Germans Road, S.E.23. Registered February 7, 1958. To take over business of "May Metals and Co." and to carry on business of contractors for and dealers in scrap and waste metals, etc. Nominal capital, £2,000 in £1 shares. Directors: Ralph C. Tarlton, Ivy V. Tarlton, Patricia E. Tarlton and John A. Harris.

**Universal Press Work Ltd.** (598782), 94 Bridge Street West, Birmingham, 15. Registered February 12, 1958. To carry on business of metal press work, etc. Nominal capital, £3,000 in £1 shares. Directors: Thomas H. Hirons, Wm. E. Hirons and Leonard Hirons.

**Ferro Exports Limited** (598988), 16 Dominion Street, E.C.2. Registered February 17, 1958. To carry on business of importers, exporters, buyers and sellers of and dealers in merchandise of all kinds, including ferrous and non-ferrous metals, etc. Nominal capital, £20,000 in £1 shares. Directors to be appointed by subscribers.

# THE STOCK EXCHANGE

## *Sentiment Encouraged By I.C.I. Results And Tendency Mainly Firm*

| ISSUED CAPITAL • | AMOUNT OF SHARE | NAME OF COMPANY | MIDDLE PRICE 31 MARCH +RISE —FALL | | DIV. FOR LAST FIN. YEAR | DIV. FOR PREV. YEAR | DIV. YIELD | 1958 HIGH | 1958 LOW | 1957 HIGH | 1957 LOW |
|---|---|---|---|---|---|---|---|---|---|---|---|
| £ | £ | | | | Per cent | Per cent | | | | | |
| 4,435,792 | 1 | Amalgamated Metal Corporation ... | 18/6 | | 10 | 10 | 10 16 3 | 19/9 | 17/9 | 28/3 | 18/– |
| 400,000 | 2/– | Anti-Attrition Metal ... ... | 1/6 | | 8½ | 7½ | 11 6 9 | 1/6 | 1/3 | 2/6 | 1/6 |
| 33,639,483 | Stk. (£1) | Associated Electrical Industries ... | 49/– | —2/– | 15 | 15 | 6 2 6 | 51/– | 47/– | 72/3 | 47/9 |
| 1,590,000 | 1 | Birfield Industries ... ... ... | 49/6 | —6d. | 15 | 20N | 6 1 3 | 53/9 | 49/6 | 70/– | 48/9 |
| 3,196,667 | 1 | Birmid Industries ... ... ... | 56/6 | —6d. | 17½ | 17½ | 6 3 9 | 57/9 | 56/3 | 80/6 | 55/9 |
| 5,630,344 | Stk. (£1) | Birmingham Small Arms ... ... | 23/10½ | —4½d. | 10 | 8 | 8 7 6 | 26/7½ | 23/9 | 33/– | 21/9 |
| 203,150 | Stk. (£1) | Ditto Cum. A. Pref. 5% ... ... | 15/7½ | | 5 | 5 | 6 8 0 | 15/7½ | 14/7½ | 16/– | 15/– |
| 350,580 | Stk. (£1) | Ditto Cum. B. Pref. 6% ... ... | 16/10½ | | 6 | 6 | 7 2 3 | 17/– | 16/6 | 19/– | 16/6 |
| 500,000 | 1 | Bolton (Thos.) & Sons ... ... | 26/10½ | | 12½ | 12½ | 9 6 0 | 28/9 | 26/10½ | 30/3 | 28/9 |
| 300,000 | 1 | Ditto Pref. 5% ... ... ... | 15/6 | | 5 | 5 | 6 9 0 | | — | 16/9 | 14/3 |
| 160,000 | 1 | Booth (James) & Co. Cum. Pref. 7% | 19/3 | | 7 | 7 | 7 5 6 | 19/3 | 19/– | 22/3 | 18/9 |
| 9,000,000 | Stk. (£1) | British Aluminium Co. ... ... | 45/– | —1/6 | 12 | 12 | 5 6 9 | 46/6 | 41/3 | 72/– | 38/3 |
| 1,500,000 | Stk. (£1) | Ditto Pref. 6% ... ... ... | 18/9 | | 6 | 6 | 6 8 0 | 19/3 | 18/4½ | 21/6 | 18/– |
| 15,000,000 | Stk. (£1) | British Insulated Callender's Cables | 40/9 | —1/3 | 12½ | 12½ | 6 2 9 | 42/– | 38/10½ | 55/– | 40/– |
| 17,047,166 | Stk. (£1) | British Oxygen Co. Ltd., Ord ... | 34/3 | —3d. | 10 | 10 | 5 16 9 | 34/6 | 29/– | 39/– | 29/6 |
| 600,000 | Stk. (5/–) | Canning (W.) & Co. ... ... | 21/– | | 25 | 25 | 5 19 0 | 21/– | 20/1½ | 24/6 | 19/3 |
| 60,484 | 1/– | Carr (Chas.) ... ... ... ... | 2/3 | | 25 | 25 | X7 15 6 | 2/3 | 2/– | 3/6 | 2/1½ |
| 150,000 | 2/– | Case (Alfred) & Co. Ltd. ... ... | 4/4½ | | 25 | 25 | 11 8 6 | 4/9 | 4/4½ | 4/6 | 4/– |
| 555,000 | 1 | Clifford (Chas.) Ltd. ... ... ... | 16/4½ | | 10 | 10 | 12 4 3 | 16/6 | 16/– | 20/6 | 15/9 |
| 45,000 | 1 | Ditto Cum. Pref. 6% ... ... | 15/10½ | | 6 | 6 | 7 11 3 | | — | 17/6 | 16/– |
| 250,000 | 2/– | Coley Metals ... ... ... | 3/3 | | 25 | 25 | 15 7 9 | 4/6 | 3/3 | 5/7½ | 3/9 |
| 8,730,596 | 1 | Cons. Zinc Corp.† ... ... ... | 47/– | +3d. | 22½ | 22½ | 9 11 6 | 51/6 | 43/– | 92/6 | 49/– |
| 1,136,233 | 1 | Davy & United ... ... ... | 46/3 | +6d. | 15 | 12½ | 6 9 9 | 48/– | 45/9 | 60/6 | 42/6 |
| 2,750,000 | 5/– | Delta Metal ... ... ... ... | 19/7½ | —3d. | 30 | •17½ | 7 12 9 | 21/4½ | 19/7½ | 28/6 | 19/– |
| 4,160,000 | Stk. (£1) | Enfield Rolling Mills Ltd. ... ... | 27/6 | | 15B | 22½ | 9 1 9 | 27/6 | 24/– | 38/6 | 25/– |
| 500,000 | 1 | Evered & Co. ... ... ... ... | 39/– | | 15 | 15 | 7 13 9 | 41/3 | 39/– | 52/9 | 42/– |
| 18,000,000 | Stk. (£1) | General Electric Co. ... ... | 30/6 | —1/1½ | 12½ | 14 | Y7 10 9 | 38/7½ | 29/6 | 59/– | 38/– |
| 1,250,000 | Stk. (10/–) | General Refractories Ltd. ... ... | 32/9 | —3d. | 20 | 17½ | 6 2 3 | 33/– | 27/3 | 37/– | 26/9 |
| 401,240 | 1 | Gibbons (Dudley) Ltd. ... ... | 65/6 | | 15 | 12 | 4 11 9 | 66/3 | 64/– | 71/– | 53/– |
| 750,000 | 5/– | Glacier Metal Co. Ltd. ... ... | 6/– | | 11½ | 11½ | 9 11 9 | 6/– | 5/7½ | 8/1½ | 5/10½ |
| 1,750,000 | 5/– | Glynwed Tubes ... ... ... | 13/6 | +3d. | 20 | 20 | 7 8 3 | 13/6 | 12/10½ | 18/– | 12/6 |
| 5,421,049 | 10/– | Goodlass Wall & Lead Industries ... | 20/–xcap | | 18Z | 16 | 6 0 0 | 20/– | 19/3 | 37/3 | 28/9 |
| 342,195 | 1 | Greenwood & Batley ... ... | 46/3 | —7½d. | 17½ | 17½ | 7 11 3 | 46/10½ | 45/– | 50/– | 46/– |
| 396,000 | 5/– | Harrison (B'ham) Ord. ... ... | 12/4½ | | •15 | •30‡ | 6 1 3 | 12/4½ | 11/6 | 16/9 | 12/4½ |
| 150,000 | 1 | Ditto Cum. Pref. 7% ... ... | 18/9 | | 7 | 7 | 7 9 3 | | — | 22/3 | 18/7½ |
| 1,075,167 | 5/– | Heenan Group ... ... ... | 7/1½ | | 10 | 20‡ | 7 0 3 | 7/7½ | 6/9 | 10/4½ | 6/9 |
| 142,045,750 | Stk. (£1) | Imperial Chemical Industries ... | 44/– | +3/6 | 12Z | 10 | 5 9 0 | 44/1½ | 36/6 | 46/6 | 36/3 |
| 33,708,769 | Stk. (£1) | Ditto Cum. Pref. 5% ... ... | 16/3 | | 5 | 5 | 6 3 0 | 17/1½ | 16/– | 18/6 | 15/6 |
| 14,584,025 | •• | International Nickel ... ... ... | 138½ | —4½ | $3.75 | $3.75 | 4 16 6 | 144½ | 135½ | 222 | 130 |
| 430,000 | 5/– | Jenks (E. P.), Ltd. ... ... ... | 7/–xcap | —3d. | 27½ ϕ | 27½ | 9 16 6 | 7/9¾ | 6/9 | 18/10½ | 15/1½ |
| 300,000 | 1 | Johnson, Matthey & Co. Cum. Pref. 5% | 16/3 | +1/3 | 5 | 5 | 6 3 0 | 16/3 | 15/– | 17/– | 14/6 |
| 3,987,435 | 1 | Ditto Ord. ... ... ... ... | 39/6 | —6d. | 10 | 9 | 5 1 3 | 41/3 | 37/6 | 58/9 | 40/– |
| 600,000 | 10/– | Keith, Blackman ... ... ... | 16/3 | | 15 | 15 | 9 4 6 | 16/3 | 15/– | 21/9 | 15/– |
| 160,000 | 4/– | London Aluminium ... ... ... | 3/1½ | —7½d. | 10 | 5 | 12 16 0 | 4/3 | 3/1½ | 6/9 | 3/6 |
| 2,400,000 | 1 | London Elec. Wire & Smith's Ord.... | 41/9 | —3d. | 12½ | 12½ | 5 19 9 | 42/– | 39/9 | 54/6 | 41/– |
| 400,000 | 1 | Ditto Pref. ... ... ... | 22/3 | —6d. | 7½ | 7½ | 6 14 9 | 22/9 | 22/3 | 25/3 | 21/9 |
| 765,012 | 1 | McKechnie Brothers Ord. ... ... | 35/– | | 15 | 15 | 8 11 6 | | — | 48/9 | 37/6 |
| 1,530,024 | 1 | Ditto A Ord. ... ... ... | 32/6 | | 15 | 15 | 9 4 6 | | — | 47/6 | 36/– |
| 1,108,268 | 5/– | Manganese Bronze & Brass ... ... | 10/3 | | 27½‡ | 25 | 6 14 3 | 10/3 | 9/– | 21/10½ | 7/6 |
| 50,628 | 6/– | Ditto (7½% N.C. Pref.) ... ... | 6/– | | 7½ | 7½ | 7 10 0 | 6/– | 5/9 | 6/6 | 5/– |
| 13,098,855 | Stk. (£1) | Metal Box ... ... ... ... | 46/9 | +9d. | 20‡ | 15M | 4 5 6 | 46/9 | 41/9 | 59/– | 40/3 |
| 415,760 | Stk. (2/–) | Metal Traders ... ... ... | 6/6 | | 50 | 50 | 15 7 9 | 6/6 | 6/3 | 8/– | 6/3 |
| 160,000 | 1 | Mint (The) Birmingham ... ... | 21/9 | | 10 | 10 | 9 4 0 | 22/9 | 21/9 | 25/– | 21/6 |
| 80,000 | 5 | Ditto Pref. 6% ... ... | 83/6 | | 6 | 6 | 7 3 9 | | — | 90/6 | 83/6 |
| 3,064,930 | Stk. (£1) | Morgan Crucible A ... ... ... | 39/– | —1/– | 10 | 11 | 5 2 6 | 40/– | 34/– | 54/– | 35/– |
| 1,000,000 | Stk. (£1) | Ditto 5½% Cum. 1st Pref. ... | 17/– | | 5½ | 5½ | 6 9 6 | 17/3 | 17/– | 19/3 | 16/– |
| 2,200,000 | Stk. (£1) | Murex ... ... ... ... | 53/6 | —1/– | 20 | 20 | 7 9 6 | 57/6 | 53/6 | 79/9 | 57/– |
| 468,000 | 5/– | Ratcliffs (Great Bridge) ... ... | 7/3 | | 10 | 10 | 6 19 0 | 7/3 | 6/10½ | 8/– | 6/10½ |
| 234,960 | 10/– | Sanderson Bros. & Newbould ... | 27/– | | 27½D | 27½ | 6 15 9 | 27/– | 26/– | 41/– | 24/9 |
| 1,365,000 | Stk. (5/–) | Serck Radiators ... ... ... | 11/6 | | 17½Z | 15 | 5 1 6 | 12/– | 11/– | 18/10½ | 11/6 |
| 600,400 | Stk. (£1) | Stone (J.) & Co. (Holdings) ... ... | 43/9 | | 16 | 16 | 7 6 6 | | — | 57/6 | 43/9 |
| 600,000 | 1 | Ditto Cum. Pref. 6½% ... ... | 20/– | | 6½ | 6½ | 6 10 0 | | — | 21/9 | 18/9 |
| 14,494,862 | Stk. (£1) | Tube Investments Ord. ... ... | 52/9 | —3d. | 15 | 15 | 5 13 9 | 53/9 | 48/4½ | 70/9 | 50/6 |
| 41,000,000 | Stk. (£1) | Vickers ... ... ... ... | 30/– | | 10 | 10 | 6 13 3 | 31/– | 29/4½ | 46/– | 29/– |
| 750,000 | Stk. (£1) | Ditto Pref. 5% ... ... ... | 15/6 | +3d | 5 | 5 | 6 9 0 | 15/6 | 14/9 | 18/– | 14/– |
| 6,863,807 | Stk. (£1) | Ditto Pref. 5% tax free ... ... | 22/– | | •5 | •5 | 6 19 9A | 23/– | 21/3 | 24/9 | 20/7½ |
| 2,200,000 | 1 | Ward (Thos. W.), Ord. ... ... | 75/– | —6d. | 20 | 15 | 5 6 9 | 75/6 | 70/9 | 83/– | 64/– |
| 2,666,034 | Stk. (£1) | Westinghouse Brake ... ... ... | 36/3 | —3d. | 10 | 18P | 5 10 3 | 36/6 | 32/6 | 85/– | 29/1½ |
| 225,000 | 2/– | Wolverhampton Die-Casting ... | 8/– | +4½d. | 25 | 40 | 6 5 0 | 8/– | 7/2½ | 10/1½ | 7/– |
| 591,000 | 5/– | Wolverhampton Metal ... ... | 15/4½ | | 27½ | 27½ | 8 19 0 | 15/6 | 14/9 | 22/3 | 14/9 |
| 78,465 | 2/6 | Wright, Bindley & Gell ... ... | 3/3 | | 20 | 17½E | 15 7 9 | 3/9½ | 3/3 | 3/9 | 2/7½ |
| 124,140 | 1 | Ditto Cum. Pref. 6% ... ... | 11/6 | | 6 | 6 | 10 8 9 | | — | 12/6 | 11/3 |
| 150,000 | 1/– | Zinc Alloy Rust Proof ... ... | 2/10½ | | 40D | 33½ | 9 5 6 | 3/1½ | 2/7½ | 5/– | 2/9 |

•Dividend paid free of Income Tax. †Incorporating Zinc Corpn. & Imperial Smelting ••Shares of no Par Value. ‡ and 100% Capitalized issue. • The figures given relate to the issue quoted in the third column. A Calculated on £7 14 6 gross. H and 200% capitalized issue. M and 10% capitalized issue. Y Calculated on 11½% dividend. ||Adjusted to allow for capitalization issue. E for 15 months. P and 100% capitalized issue, also "rights" issue of 2 new shares at 35/– per share or £3 stock held. D and 50% capitalized issue. Z and 50% capitalized issue. B equivalent to 12½% on existing Ordinary Capital after 100% capitalized issue. ϕ And 100% capitalized issue. X Calculated on 17½%.